VIBRATION TEST EQUIPMENT

VIBRATION CONTROL SYSTEM

MODEL 400AT

RANDOM VIBRATION TESTING

UNHOLTZ-DICKIE CORPORATION

VIBRATION CONTROL SYSTEM

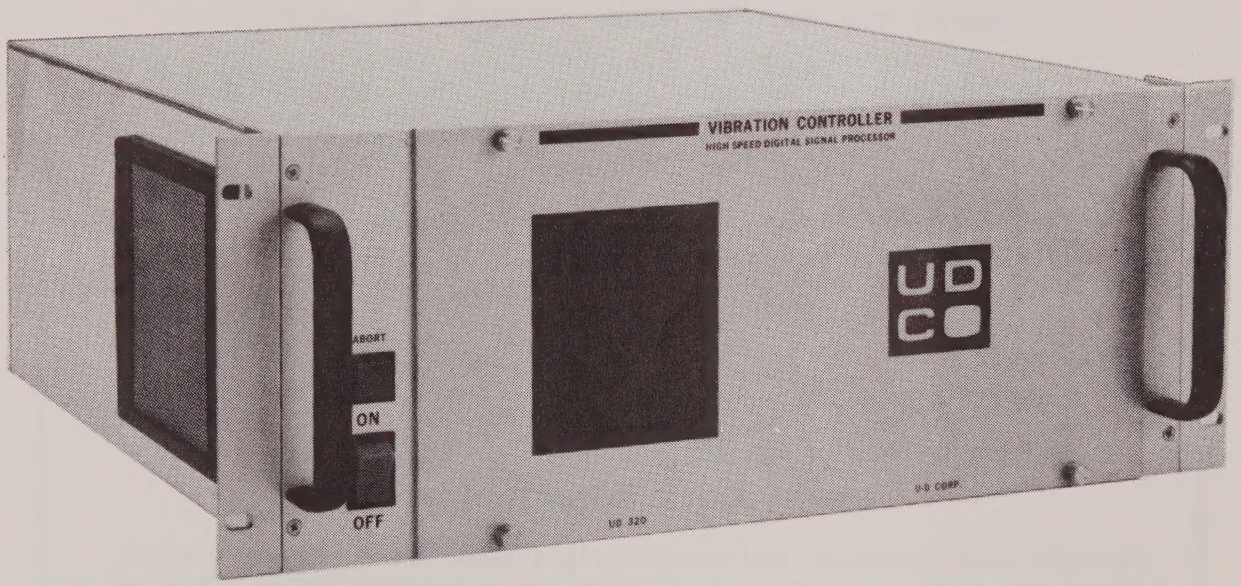
MODEL 400AT

RANDOM VIBRATION TESTING

Digitized by the Internet Archive
in 2025

https://archive.org/details/manualsplus_09980

The Heart of the 400AT Vibration Control System



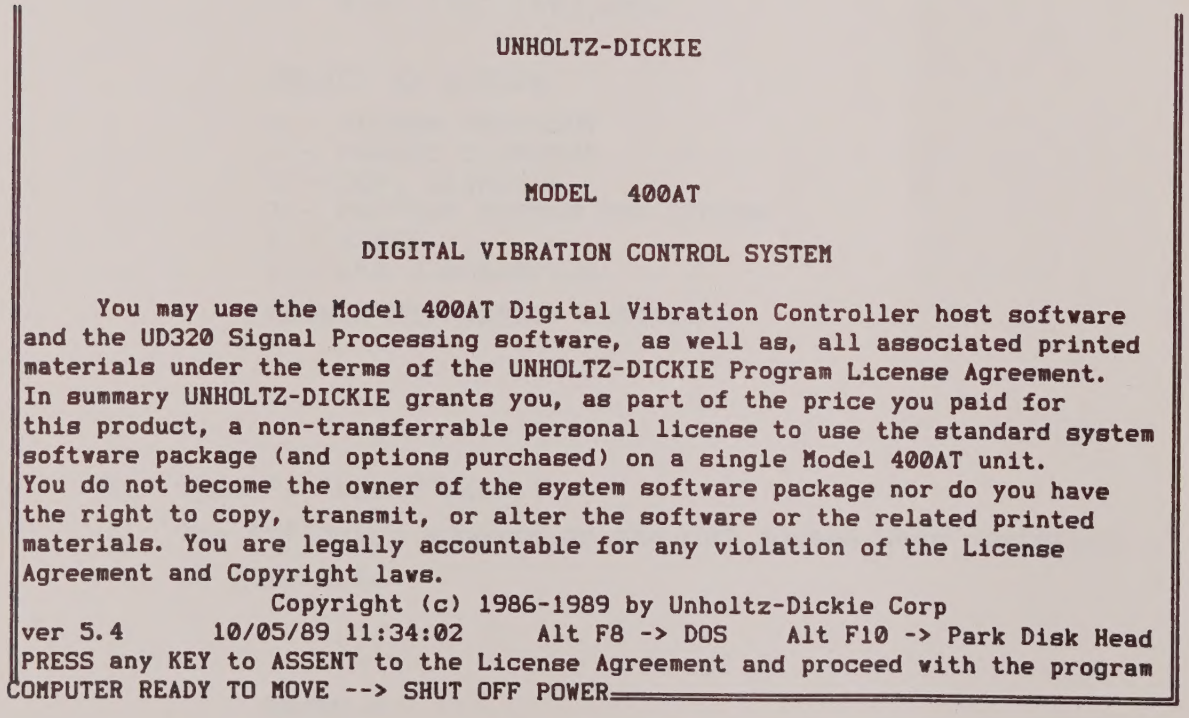
Front View

Model UD320 High Speed Digital Signal Processor

---------- IMPORTANT ----------

THE HEAD OF THE HARD DISK MUST BE PARKED OFF THE DISK BEFORE MOVING THE SYSTEM. DAMAGE TO THE UNIT MAY OCCUR IF THIS IS NOT DONE. TO PARK THE HEAD, FOLLOW THE INSTRUCTIONS BELOW.

1. Turn the AC power on.
2. Go to the UD Title Page for the 400AT System,
3. Press the (Alt) and (F10) keys simultaneously.
4. After a short interval, the Title Page appears as below with the addition at the bottom, "COMPUTER READY TO MOVE --> SHUT OFF POWER".


UNHOLTZ-DICKIE
MODEL 400AT
DIGITAL VIBRATION CONTROL SYSTEM
You may use the Model 400AT Digital Vibration Controller host software and the UD320 Signal Processing software, as well as, all associated printed materials under the terms of the UNHOLTZ-DICKIE Program License Agreement. In summary UNHOLTZ-DICKIE grants you, as part of the price you paid for this product, a non-transferrable personal license to use the standard system software package (and options purchased) on a single Model 400AT unit. You do not become the owner of the system software package nor do you have the right to copy, transmit, or alter the software or the related printed materials. You are legally accountable for any violation of the License Agreement and Copyright laws.
Copyright (c) 1986-1989 by Unholtz-Dickie Corp
ver 5.4 10/05/89 11:34:02 Alt F8 -> DOS Alt F10 -> Park Disk Head
PRESS any KEY to ASSENT to the License Agreement and proceed with the program
COMPUTER READY TO MOVE --> SHUT OFF POWER

5. The computer should be insensitive to further keyboard commands. TURN THE AC POWER OFF.
6. Insert the protective cardboard diskette into the Floppy Drive.
7. The System may now be moved safely.

IMPORTANT

ALTERNATE METHOD TO PARK THE HARD DISK HEAD.

PARK THE HEAD OF THE FIXED DISK BEFORE MOVING THE SYSTEM TO PREVENT DAMAGE TO THE HARD DISK.

1) Insert the IBM diagnostics diskette.
2) Turn PC AT AC power OFF, then back ON.
3) After approximately thirty seconds the following appears on the CRT screen.

```
The IBM Personal Computer
ADVANCED DIAGNOSTICS
Version 1.02
(C) Copyright IBM Corp.
    1981,1982,1983,1984

SELECT AN OPTION

0 - SYSTEM CHECKOUT
1 - FORMAT DISKETTE
2 - COPY DISKETTE
3 - PREPARE SYSTEM FOR MOVING
4 - SETUP
9 - END DIAGNOSTICS

SELECT THE ACTION DESIRED
?
```

4) Type "3" then "Enter"
5) The following appears on the CRT screen when operation is complete.

```
DRIVE C
IS PREPARED FOR MOVING
TURN SYSTEM OFF
?
```

6) Remove diagnostic diskette and turn power OFF.
   Insert the protective cardboard diskette.

UNHOLTZ-DICKIE END USER LICENSE AGREEMENT FOR THE DIGITAL VIBRATION CONTROL PROGRAM

Prior to using this Unholtz-Dickie digital vibration control product, you should review the following UNHOLTZ-DICKIE End User License Agreement.

The computer program is provided on the condition that the End User agrees to the following at the time of receiving the program.

1 - The UNHOLTZ-DICKIE vibration control computer program and manual are protected by copyright laws.

2 - When the End User receives the vibration control computer program, the acceptance of the program acts as a license to use the program. This license may be revoked at any time by UNHOLTZ-DICKIE if the End User is found to be in breach of the copyright laws or any part of this Agreement.

3 - This license allows the End User to use and display the program on a single computer. You may physically transfer the program from one computer to another provided that the program is used on only one computer at a time.

4 - End Users may make copies of the program for back-up purposes only. Distribution or sale of back-up copies is a violation of copyright laws and is forbidden.

5 - As the End User, you own the magnetic or other physical media on which the program is recorded but UNHOLTZ-DICKIE retains title and ownership of the program recorded on the original disk and all subsequent back-up copies.

6 - The program is licensed only to you, the End User, and may not be transferred to anyone without the prior written consent of UNHOLTZ-DICKIE.

7 - This license is effective until terminated. This license will terminate automatically without notice from UNHOLTZ-DICKIE if you fail to comply with any provision of this license. Upon termination, you shall destroy the written materials and all copies of the program.

8 - UNHOLTZ-DICKIE may create updated versions of the program. At its option, UNHOLTZ-DICKIE will make such updates available to the End User. A fee may be charged for such updates.

TABLE OF CONTENTS

Chapter	Subject
1	SYSTEM OVERVIEW AND THEORY OF OPERATION
2	INSTALLATION - INTERCONNECTIONS
3	PRELIMINARY SYSTEM OPERATION - RANDOM VIBRATION TESTING
4	PERFORMING THE RANDOM VIBRATION TEST
5	SAVING AND RETRIEVING DATA
6	COPYING OPERATIONS
7	MEASUREMENT AND ANALYSIS OF SIGNALS

SUMMARY - CHAPTER 1

SYSTEM OVERVIEW AND THEORY OF OPERATION

SUBJECT		PAGE
1.1	GENERAL SYSTEM DESCRIPTION AND OBJECTIVES	1-2
1.2	SYSTEM CONFIGURATION	1-3
1.2.1	VCS Signal Flow	1-4
1.2.2	System Host	1-4
1.2.3	High Speed Digital Signal Processor (HSDSP)	1-7
1.3	CONTROL TECHNIQUE AND PERFORMANCE	1-8
1.3.1	Test Frequency and Sampling Parameters	1-10
1.3.2	Basic Control Technique	1-12
1.3.3	Digital Signal Processing Details	1-13
1.3.4	Statistical Control Accuracy	1-16
1.3.5	Response Time	1-18
1.4	OPERATIONAL FEATURES	1-21
1.4.1	Specification of the Control Reference PSD	1-21
1.4.2	Spectral Line Alarm Limit Checks	1-21
1.4.3	Spectral Line Abort Limit Checks	1-21
1.4.4	Wideband Acceleration Abort Limits	1-22
1.4.5	Average Control	1-23
1.4.6	Variable Bandwidth Averaging	1-24
1.4.7	Drive Voltage Signal Clipping	1-25
1.4.8	Level Schedule	1-25
1.4.9	Extremal Control (optional)	1-25
1.5	MODES OF OPERATION	1-26
1.5.1	Test Setup	1-26
1.5.2	Test Run	1-27
1.5.3	Test Sequence	1-28
1.5.4	Test Data	1-29
1.6	KEY SPECIFICATIONS	1-30

1. SYSTEM OVERVIEW AND THEORY OF OPERATION

1.1 GENERAL SYSTEM DESCRIPTION AND OBJECTIVES

The U-D Model 400AT Vibration Control System (VCS) is used in conjunction with a vibration test system (VTS), consisting of a power amplifier, shaker, test specimen, accelerometers and signal conditioners. For random vibration testing it provides real-time, closed-loop operation to cause the power spectral density (PSD) of the test system acceleration response to match a user-defined reference PSD within acceptable tolerances. To accomplish this, the VCS continuously processes the sampled acceleration input signal in order to measure system frequency response function and then calculate the power amplifier drive voltage PSD required to produce the reference PSD at the test specimen. The VCS then synthesizes a continuous random drive voltage in the time domain, having the required PSD and a gaussian amplitude distribution.

The VCS also provides the means to:

1 - Define the various test parameters and to initiate the test through keyboard entry.

2 - Acquire and digitize the accelerometer input signal(s) from the charge amplifier(s).

3 - Execute a test in a completely automatic mode which may be manually overridden.

4 - Monitor a test by means of real-time test graph displays and status messages.

5 - Perform error checking and provide quick and transient free shutdown when abort conditions exist.

6 - Allow means for remote control (optional).

7 - Store and provide hard copy for test setup parameters and test data.

1.2 SYSTEM CONFIGURATION

The block diagram of the U-D Model 400AT VCS in conjunction with a typical vibration test system is shown in Figure 1-1. The VCS consists of a system host and the UD320 High Speed Digital Signal Processor (HSDSP). Commands and data flow between the System Host and the HSDSP through the IEEE-488 standard interface. The System Host also provides an external interface for remote control of the VCS. The HSDSP provides the drive signal voltage for the power amplifier and accepts a total of eight input signals which represent the acceleration at various points on the test specimen. All eight inputs may be selectively multiplexed and used for control purposes. Also, any one of the eight inputs, regardless of its use as a control input, may be independently selected for measurement purposes only. In addition the HSDSP provides one abort input and a buffered output providing the multiplexed control signals.

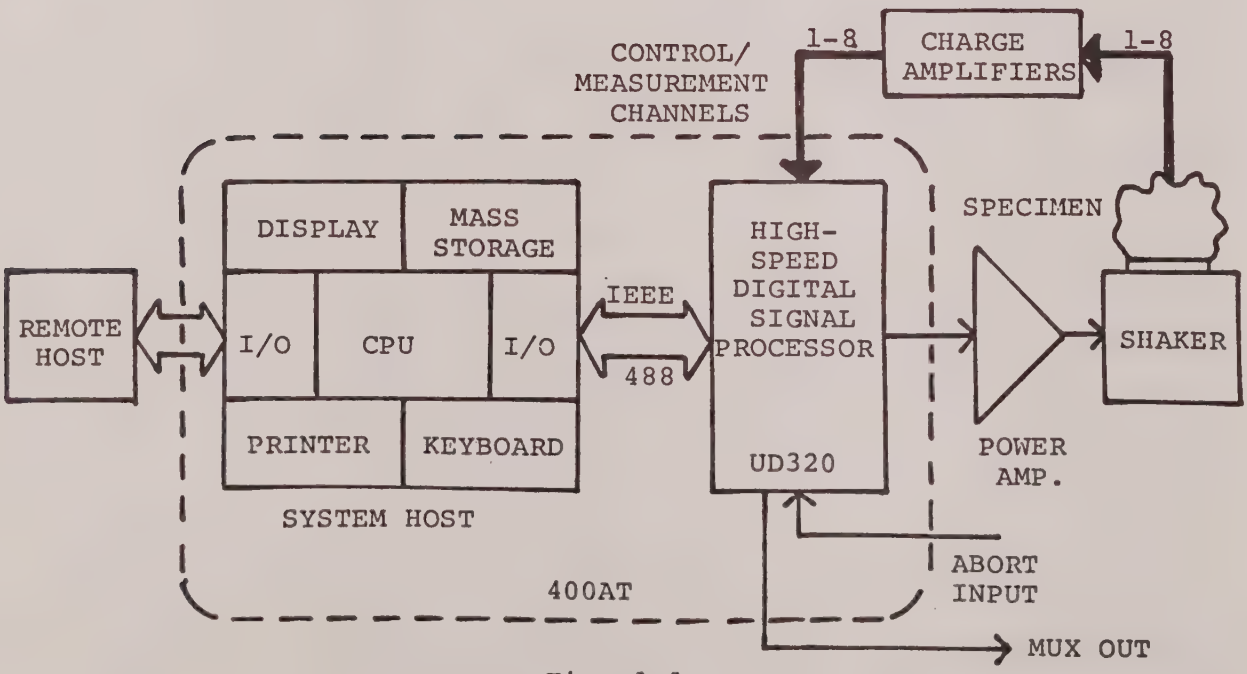


Fig. 1-1
Block Diagram - Vibration Test System

lution color display and graphic interface, an 80287 math co-processor, dot-matrix printer, a clock calendar with battery backup, a keyboard, an IEEE-488 interface, and the DOS operating system. Primarily the System Host is used to set up, initiate and monitor tests, and also to record and to provide hard copy of test results.

The operator enters the test parameters by means of the keyboard at the System Host in response to a series of simple menus and prompts. The System Host boots directly to the vibration test menu when AC power is applied.

For monitoring tests in progress the System Host provides continually-updated, fully-annotated, high-quality color graphic displays of acceleration PSD's, reference PSD, alarm and abort limits, drive voltage PSD, and the test system transfer function.

Appropriate messages are also displayed, including rms acceleration, current test level, duration of test, frequency resolution, degrees of freedom (DOF), control channel sequence, fixed/variable bandwidth, time of day, date, error conditions, and alarm and abort conditions.

Single keystroke commands allow the System Host to select and control various test modes. For test protection, the system key allows lockout of all keyboard functions. An abort button provided at the HSDSP is operational, regardless of the state of the keyboard.

The hard disk provides storage for at least 100 test setups and for test data from at least 100 separate test runs. Back-up and archiving is accomplished with floppy disk.

The high speed graphics printer provides hard copy of test setups and graphs of test data. The test setups are suitably organized wherever possible in tabular form. The graphs of test data are rotated 90° when printed to provide approximately the same aspect ratio on the 8-1/2 x 11 sheet as is attained on the color monitor, thus maximizing the size of the hard copy graphs.

A communication interface is provided to a remote host for overall system control (optional). Rudimentary commands to start, stop, select a test setup and test mode, and to request status are implemented.

The System Host, aside from the specific function of test control, may also act as a general purpose computer to run any IBM PC AT software and to allow for development of user-specified programs.

1.2.3 UD320 High Speed Digital Signal Processor (HSDSP)

The signal flow diagram in Fig 1-2 also contains the block diagram for the HSDSP. Five cards are contained in the HSDSP: Analog Input interface (AI), Analog Output interface (AO), Input Processor, Output Processor and Host Interface Processor. The latter three cards have identical hardware, each based on the TMS32010 digital signal processing single chip microcomputer. These three processor boards perform all high-speed, real-time calculations necessary for test control and error checking, as outlined in Section 1.2.1. Expansion slots are provided for additional signal processing and analog interface cards. This, together with the capability of loading different software into each signal processing card, provides the flexibility for the control system to be used for other types of vibration test control.

An extremely important facet of the operation of the AO and AI cards deserves further explanation. The Input and Output Processor cards normally work with two volt rms input and output signals at the respective digital interfaces of the signal processing boards. The discrete gain amplifiers on the AI and AO cards are set at the beginning of the test, the settings having been determined from the maximum rms acceleration test level and the vibration test system gain (g/v). The system gain is automatically calculated during a pre-test autoranging procedure. The level scaling stages on the AI and AO cards are adjusted during the test to obtain each of the test levels specified in the test level schedule. The input level scaling amplifies the acceleration input signal, whereas the output level scaling generally attenuates the amplifier drive signal.

Figure 1-3 shows the relative signal levels at the input to the Input Processor, the output of the Output Processor, the two level scaling factors and the output of the AO card for both an increase and a decrease in test level. Note that the data envelope for both the Input Processor and the Output Processor are kept at 2 volts rms except for a single transition time frame of data. This procedure has the advantage of allowing the test level to be increased or decreased smoothly and quickly without requiring the digital signal processing cards to make changes in signal level to accommodate the level change. If level changes in the digital processing cards were used, they would decrease signal to noise ratio due to increased data clipping or decreased level of signal to the fixed digitization noise. Also, if the PSD averaging circuits in the digital processing cards were involved in the changing of output signal level, the time to make the level change would be much longer than one data frame.

Two other operational advantages occur because of the wide range of gain settings available in the discrete gain stages of the AI and AO cards. First, the user may use good-quality acceleration signals having a single sensitivity (10 mV/g) for all vibration tests. The user is never confronted with the response "INPUT SENSITIVITY TOO LOW", on the video display, as is the case with competitive systems. Second, there is no need to adjust the gain of the power amplifier at any other value except the maximum setting, since sufficient attenuation is available in the VCS, even for tests having very low rms acceleration levels.

1.3 CONTROL TECHNIQUE AND PERFORMANCE

It has been noted in many publications that the frequency response of the VTS is not flat, and not even particularly smooth. Resonances within the shaker structure and in the specimen being tested all combine to give a frequency response function having a number of peaks and notches, most of which may exhibit narrow bandwidths.

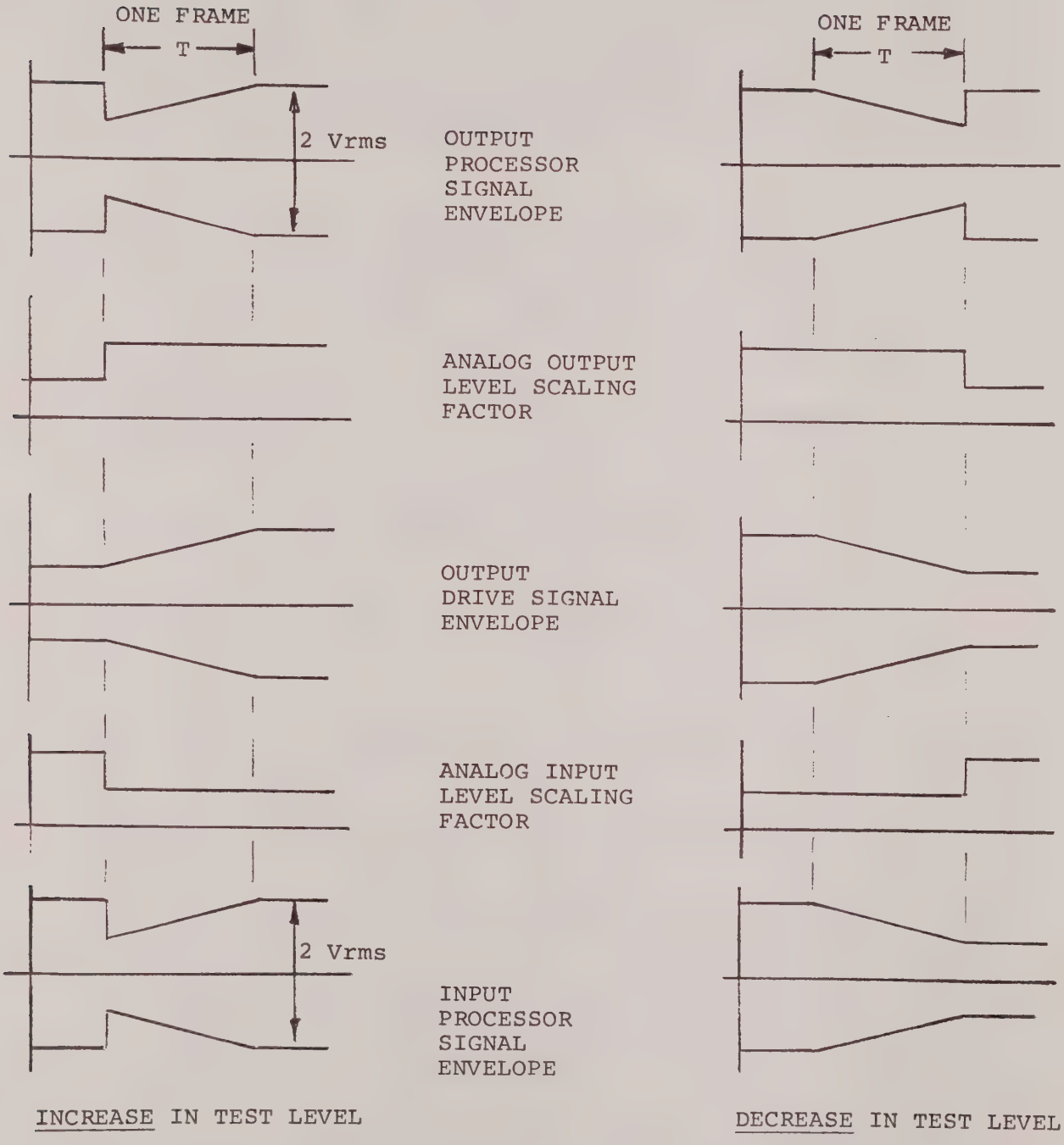


Fig. 1-3

Signal Levels for Change in Test Level
as Functions of Time

Since the reference PSD is generally not flat, either, the required drive voltage PSD is far from being flat, since it must also compensate for the effects in the frequency response function to produce the desired reference PSD at the output of the VTS. A simplified representation of the VCS and VTS is shown in Fig. 1-4.

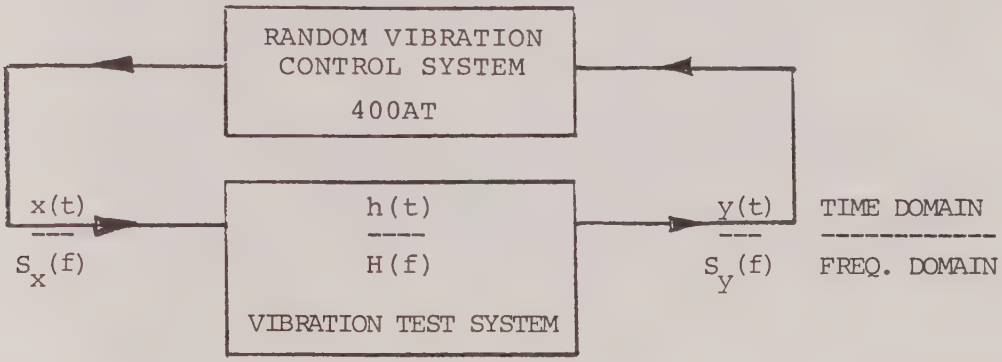


Fig. 1-4
Simplified Representation of the
Random Vibration Test System

Since the VCS is a digital system, the functions x(t) and y(t) are actually sets of equally spaced samples of these variables in the time domain, and sampled-data theory applies as far as operations within the VCS are concerned. Random signal theory and statistical theory are of prime importance also, since x(t) and y(t) are also random variables. Because of the statistical nature of x(t) and y(t), operation with just one frame or set of equally spaced samples is not useful by itself, and consequentially operations with a larger number of frames of data are necessary to obtain useful measurements for analysis and control.

1.3.1 Test Frequency and Sampling Parameters

The U-D VCS provides four different test frequency ranges for spectral analysis and control, and three different values for the number of data samples, N, within each frame. The sampling frequency, f_s, is approximately four times the width of the useful test frequency range. The test frequency resolution or spectral

line spacing, Δf, is given by the relation

$$\Delta f = f_s/N \qquad (1\text{-}1)$$

since there are as many individual spectral lines in the band from 0 to f_s (Hz) as there are data samples within one time frame. Note, however, that the useful number of spectral lines is limited to those within the test frequency range (approximately N/4).

Sampling theory limits the maximum analysis frequency to one-half the sampling frequency due to the folding phenomenon. However, the useful analysis range is considerably less. The anti-aliasing filters in the U-D VCS reject the "folding components" at least 60 dB over the entire test frequency range. The sampling parameters are summarized in Tables 1-1 and 1-2.

TEST FREQUENCY RESOLUTION (Hz)

TEST RANGE f_t (Hz)	SAMPLING FREQUENCY f_s (Hz)	USEFUL NO. OF SPECTRAL LINES		
		500	250	125
2500	10240	5.0 Hz	10.0 Hz	20 Hz
1250	5120	2.5	5.0	10
625	2560	1.25	2.5	5
250	1024	0.5	1.0	2

TEST FREQ. RES. (Hz)-Δf

TABLE 1-1: Test Frequency Resolution as a Function of Frequency Range and Number of Spectral Lines

TEST RANGE (Hz)	SAMPLING FREQUENCY (Hz)	NO. OF SAMPLES/FRAME		
		2048	1024	512
2500	10240	0.2 s	0.1 s	0.05 s
1250	5120	0.4	0.2	0.1
625	2560	0.8	0.4	0.2
250	1024	2.0	1.0	0.5

FRAME LENGTH (s) - T

TABLE 1-2: Frame Length as a Function of Test Range and Number of Samples/Frame

Note that the relation between frame time T, and frequency resolution f, is given by

$$T = 1/\Delta f \tag{1-2}$$

1.3.2 Basic Control Technique

The basic control technique for shaping the acceleration PSD to closely match the reference PSD was mentioned in Section 1.1 and will be further explained in this and following sections.

The frequency domain representations of x(t) and y(t) in Fig. 1-4 are the drive voltage spectrum, $S_x(f)$, and the output acceleration spectrum, $S_y(f)$. These spectra are actually Fourier Transforms of the large number of equally spaced samples that describe x(t) and y(t) during a single time frame, T. In the VCS, a Fast Fourier Transform (FFT) algorithm is used to compute $S_y(f)$, which has a value at each of the spectral line frequencies discussed in Section 1.3.1.

The PSD for a single frame of acceleration samples, y(t), is defined in Eq (1-3)

$$G_{yy}(f) = KS_yS_y^* \tag{1-3}$$

where K is a proportionality constant. However, since y(t) is a random variable, the PSD as calculated in Eq (1-3) is also a random variable, and has a standard deviation approximately equal to its mean value. Thus, it is not statistically useful by itself, and the results for a number of frames are averaged to provide a meaningful estimate of the mean value $\overline{G_{yy}(f)}$. The averaging technique is discussed in a later section.

The following relationships are also useful:

$$G_{xx}(f) = K|S_x|^2 \tag{1-4}$$

and

$$G_{rr}(f) = K|S_r|^2 \tag{1-5}$$

where $G_{xx}(f)$ is the drive voltage PSD and $G_{rr}(f)$ is the user-defined reference PSD for the output acceleration.

The basic relationship between the input and output parameters in the frequency domain is given by Eqs (1-6) and (1-7).

$$S_y(f) = H(f)\, S_x(f) \quad (1\text{-}6)$$

$$G_{yy}(f) = |H|^2\, G_{xx}(f) \quad (1\text{-}7)$$

Since $|H|$ is unknown, the control technique involves making successive estimates of $|H|$. The drive voltage is synthesized by specifying $S_x(f)$, randomizing the phase angle of $S_x(f)$ and utilizing an interpolative Inverse Fast Fourier Transform (FFT^{-1}) algorithm. An initial set of $S_x(f)$ is used to synthesize a drive voltage x(t), which causes y(t), and the average PSD, $\overline{G_{yy}(f)}$, is measured. These initial values yield an initial estimate of $|H|^{-1}$:

$$|H|_1^{-1} = \left[\overline{G_{xx}}/\overline{G_{yy}}\right]^{1/2} \quad (1\text{-}8)$$

Note that an averaged value for G_{xx} is also indicated. This will be discussed in a later section. The initial estimate is done at a low test level.

The initial estimate for $|H|^{-1}$ is then used with the desired value for $\overline{G_{yy}}$, which is G_{rr} or KS_r^2, to yield new values for $|S_x|$:

$$|S_x|_{(n)} = S_r\, |H|^{-1}_{(n-1)} \quad (1\text{-}9)$$

The new set of values for $|S_x|$ yields an updated value for $\overline{G_{xx}}$, which with the resulting updated measurement for $\overline{G_{yy}}$ gives a new value for $|H|^{-1}$:

$$|H|^{-1} = \left[\overline{G_{xx(n)}}/\overline{G_{yy(n)}}\right]^{1/2} \quad (1\text{-}10)$$

Equations (1-9) and (1-10) are reapplied periodically to provide new estimates for $|H|^{-1}$ and new values for $\overline{G_{yy}}$. The value for $\overline{G_{yy}}$ approaches the reference PSD, G_{rr}, within a statistical deviation which will be discussed in a following section.

1.3.3 Digital Signal Processing Details

Figure 1-5 shows further details of the HSDSP, particularly processing details carried out in the Input Processor, Output Processor, and Host Interface Processor Cards.

In the Input Processor, a Hanning window is applied to the digital samples of y(t) in each frame, before the FFT is calculated. This operation makes spectrum values for adjacent spectral lines not totally independent of each other, and reduces the actual resolution somewhat, but makes the interdependence of lines spaced further apart very small. Omission of the Hanning window would cause

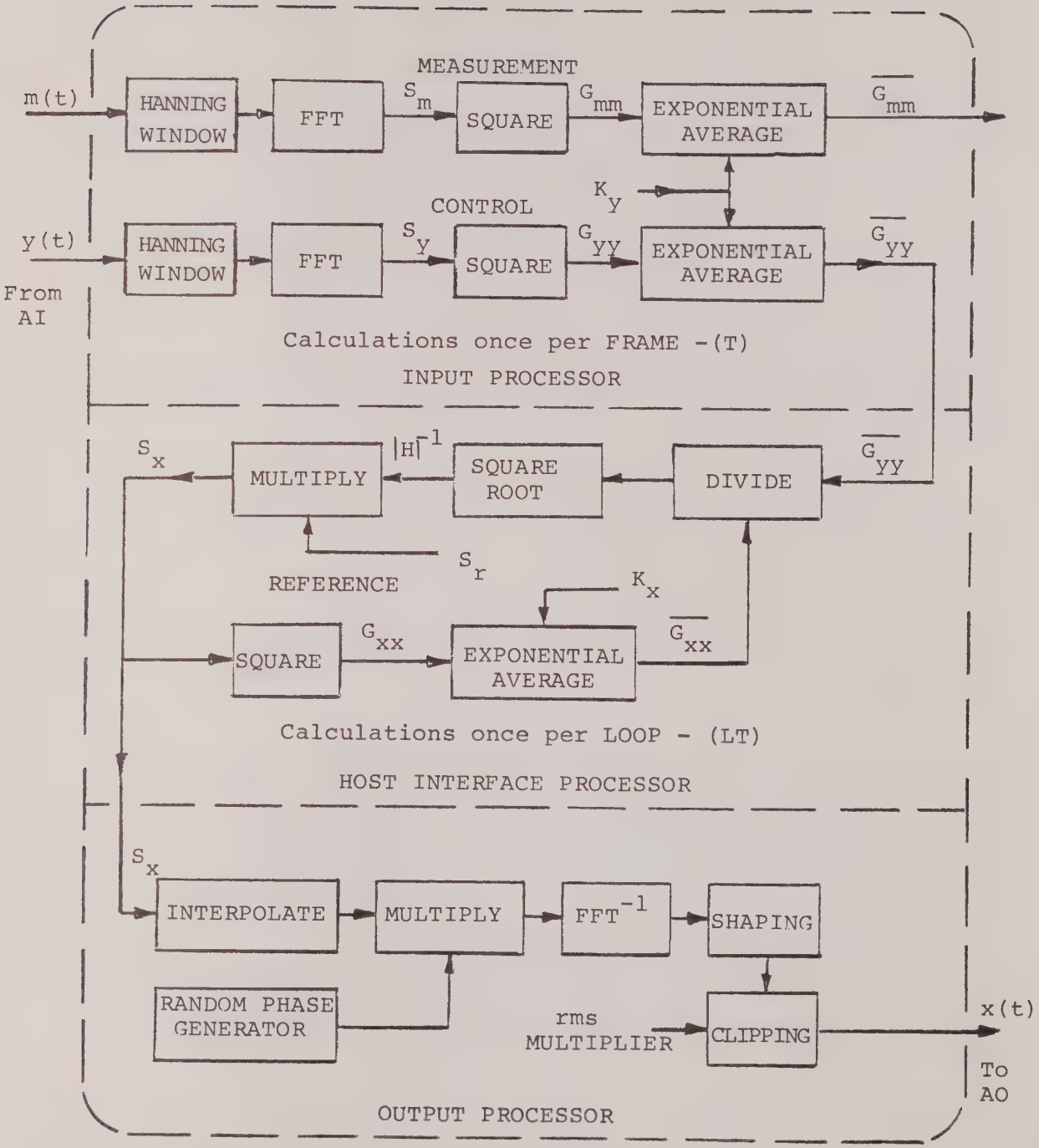


Fig. 1-5
Digital Calculations and Data Flow

much higher interdependence of lines having reasonably large spacing and consequent measurement errors, particularly for random variables.

Averaging of spectral data in the U-D VCS is done by means of an exponential averager. A new value of Gyy is produced after every frame of data by means of the rule in Eq (1-11).

$$\overline{G_{yy(n)}} = \overline{G_{yy(n-1)}} + [G_{yy(n)} - \overline{G_{yy(n-1)}}]/K_y \qquad (1\text{-}11)$$

where: $G_{yy(n)}$ is the PSD for the nth frame of data (Eq (1-3)).

$\overline{G_{yy(n)}}$ is the exponentially averaged PSD after the nth frame of data.

$\overline{G_{yy(n-1)}}$ is the exponentially averaged PSD after the (n-1)th frame.

K_y is the frame discount factor (>1).

Note that the recursive relation in Eq. (1-11) means that all previous values of G_{yy} affect the value of $\overline{G_{yy(n)}}$, but the most recent values of G_{yy} have the most prominent effect.

The same averaging rule is used for both the control channel and the measurement channel.

The value of K_y affects both the response time of the control loop and the statistical accuracy of the control loop. In general, as K_y increases, the statistical accuracy is improved and the response time or equalization time of the loop increases. A compromise between these two effects must be chosen by the operator.

The Host Interface Processor provides the calculations outlined in Eqs. (1-8), (1-9), and (1-10) in Section 1.3.2. These calculations are done at the completion of each loop time, which is chosen to be an integer number of frames, L.

The calculated drive voltage PSD, G_{xx}, from Eqs (1-9) and (1-5), has essentially the same uncertainty as $\overline{G_{yy}}$, but it is exponentially averaged, as well, in the Host Interface Processor. This is done once every frame also, not to decrease the uncertainty, but to provide the control loop with optimum dynamic response

characteristics in responding to any change in $|H|$ occurring during the actual test. Note that the calculation of $|H|^{-1}$ is done only once every L frames.

After every frame the new value of $\overline{G_{xx}}$ is determined by the rule

$$\overline{G_{xx(n)}} = \overline{G_{xx(n-1)}} + [G_{xx(n)} - \overline{G_{xx(n-1)}}]/K_x \qquad (1\text{-}12)$$

Where: $G_{xx(n)}$ is the PSD after the nth frame

$\overline{G_{xx(n)}}$ is the exponentially averaged PSD after the nth frame

$\overline{G_{xx(n-1)}}$ is the exponentially averaged PSD after the (n-1)th frame

K_x is the loop discount factor.

The factor K_x is determined by the VCS and depends on the value of K_y. Model studies and theoretical considerations confirm that for critically damped closed loop response of the VCS and VTS, $K_x = K_y$. If $K_x < K_y$, the response tends to be oscillatory (underdamped), and if $K_x > K_y$, the response is excessively slow (overdamped). Thus K_x is chosen

$$K_x = K_y \qquad (1\text{-}13)$$

to give the shortest loop response time without significant overshoot in the response.

Studies have also shown that choosing a small value of L, that is, making loop corrections very often, does not improve loop response time. Making L very large (much greater than K_y) does not allow the averaging effects upon G_{yy} to be observed frequently enough.

The VCS thus chooses L based on the following rule:

$$\begin{aligned} &\text{For } K_y \leq 16 \quad L = 8 \\ &\quad K_y \geq 16 \quad L = K_y/2 \end{aligned} \qquad (1\text{-}14)$$

The operator's choice of K_y is based on the desired statistical accuracy of the control system which is discussed in the next section.

1.3.4 Statistical Control Accuracy

Estimates of PSD such as those performed in the VCS are themselves

random variables and their probability distributions are described by the "chi-square" distribution. The fundamental parameter of the "chi-square" distribution is the equivalent number of degrees of freedom (DOF).

The DOF essentially indicates how many equivalent averages of independent variables were used to compute the final estimate of the control PSD or how long the averaging time happened to be. The relation between the DOF, the "confidence level", and the "confidence interval" in ±dB is given by[1]

$$DOF = A/(dB)^2 + 1 \qquad (1\text{-}15)$$

where A depends on the "confidence level" and dB is one half the total "confidence interval". Table 1-3 gives the DOF required for various combinations of confidence levels and confidence intervals.

CONTROL ACCURACY OR CONFIDENCE INTERVAL (dB)	CONFIDENCE LEVELS				
	50%	80%	90%	95%	98%
	A=15	A=64	A=100	A=140	A=210
±0.5 dB	61	257	401	561	841
±1.0 dB	16	65	101	141	211
±1.5 dB	*	30	45	63	94
±2.0 dB	*	17	26	36	54
±3.0 dB	*	*	12	17	24

*DOF < 10

Table 1-3 DOF as a Function of Confidence Interval and Confidence Level

The results in Table 1-3 deserve further interpretation. Suppose dB = ±1 and confidence level = 90%. From statistical theory we can thus say that the measurement of PSD with 101 degrees of free-

[1] R.B. Blackman and J.W. Tukey, The Measurement Of Power Spectra, p.23 Dover Publications, New York, 1959.

dom will yield a PSD value which is within ±1 dB of the true value with 90% confidence (probability). However, note that the VCS is simultaneously displaying at least 125 (see Table 1-1) of such estimates and these are expected to fluctuate above and below the reference spectrum, due to the action of the control loop and the statistical nature of the signals.

We can thus expect the PSD values on the display to be within ±1 dB of the reference PSD with 90% confidence or probability. Also, if a 500 line display were chosen (Table 1-1) we can expect approximately (1-0.9)(500) or 50 lines to be outside the ±1 dB interval on any display. In this fashion, the confidence interval can be considered to be a statement of control accuracy. This control accuracy can be maintained by the VCS as long as the frequency response of the load does not have peaks and notches whose bandwidths are less than about twice the test frequency resolution (Table 1-1), and as long as the reference spectrum does not require more than 5 dB change per spectral line separation.

Finally, it is important to determine the relationship between Ky and DOF. For a "true averager" utilizing M frames of data, all having equal weight, it can be shown[2] that

$$M = .44(DOF) \tag{1-16}$$

This result takes into account that the actual resolution is approximately 1.5 times the test frequency resolution given in Table 1-1 due to the Hanning weight of the data samples. Also, the "exponential averager" with discount factor K_y is equivalent to a "true averager" operating on $(2K_y-1)$ frames of data:

$$M = 2K_y - 1 \tag{1-17}$$

Combining Eqs (1-16) and (1-17) we have

$$K_y = .22(DOF) + 0.5 \tag{1-18}$$

1.3.5 Response Time

All parts of the HSDSP in the U-D VCS are able to start processing new data or perform new operations on data presented from other

[2] Ibid, p. 57

parts of the processor as soon as the data is available. In other words, 100% real time operation is possible with the HSDSP. No delays are incurred by requests from the host. The exponential averager requires a given amount of time in order to obtain the desired statistical control accuracy. Loop calculations are done sufficiently often so as not to degrade response time, and loop dynamics are chosen to optimize response time and not provide excessive overshoot.

The VCS response time to changes in the frequency response function of the VTS is thus proportional to the product of the frame discount factor and the frame time:

$$\text{VCS Response Time} = CK_yT \qquad (1\text{-}19)$$

By utilizing the results in Eqs (1-18), (1-15), and (1-2) we have:

$$\text{CVS Response Time} = D(\text{dB})^{-2}(\Delta f)^{-1} \qquad (1\text{-}20)$$

In Eqs. (1-19) and (1-20), C and D are proportionality constants. From Eq (1-20) we find that frequency resolution (Δf) and confidence interval (dB) should not be chosen any smaller than is absolutely necessary, since response time increases due to the inverse relationship. This is particularly true for the confidence interval, since the response time increases by a factor of 4 as a result of decreasing the confidence limit by a factor of 2.

If $|H|$ has a sudden 10 dB change (step input), the time taken to equalize the acceleration PSD to within 1 dB of the reference is less than 11 seconds for a test with a ± 1 dB confidence interval and 90% confidence level and 10 Hz resolution (Δf). Other response times can be scaled from Eq (1-20) from this benchmark.

It should be reemphasized that system response time is determined purely by the choice of statistical accuracy parameters and frequency resolution since the HSDSP is continuously processing available data. Competitive systems advertise very short "loop times" and a connection with short response time is implied. This is not the case, however, and the "loop time" is simply the time interval between successive calculations to provide corrections to the drive voltage. If the loop time is very short, the output of

the averager calculating the acceleration PSD does not change very much in the time interval between successive calculations, and consequently, the corrections to the drive voltage are also small. This is why excessively short loop times (L times T) do not affect the system response time. However, the U-D Model 400AT is capable of specifying short loop times of one second or less if the operator desires.

To illustrate the previous description Fig. 1-6 shows a typical response of a single spectral line for two different values of L. In each case K_y is the same and K_x is adjusted for optimum response. For the smaller value of L, the corrections after each loop time are also smaller, and the total response time for each case is essentially the same.

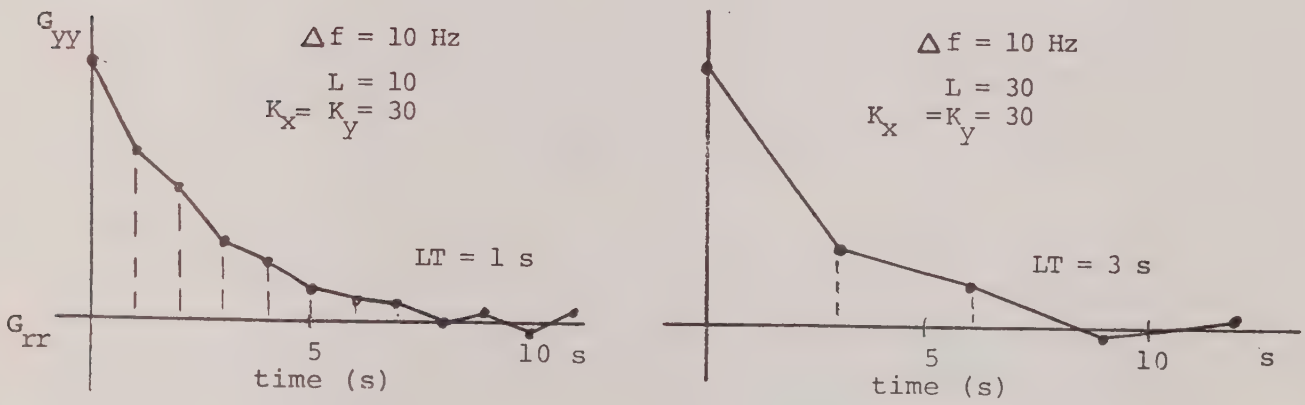


Fig. 1-6
Spectral Line Response for Different Loop Times

1.4 OPERATIONAL FEATURES

This section provides a discussion of operational features that have not been mentioned previously.

1.4.1 Specification Of The Control Reference PSD

The Reference PSD may be specified by the operator using one of four possible methods.

1 - Defining a new PSD by specifying the initial and final slopes with intermediate breakpoint frequencies and corresponding PSD values in g^2/Hz. As many as 42 breakpoints may be entered with separate alarm and abort limits assigned between successive breakpoints. It is assumed that logarithmic scales of amplitude and frequency are used and that the PSD's between breakpoints are described by straight lines.
2 - Recalling an actual PSD from a previously completed test.
3 - Duplicating a reference PSD defined in another test setup.
4 - Changing the level (scaling) of an existing reference PSD.

1.4.2 Spectral Line Alarm Limit Checks

Alarm limits are defined in dB relative to the Reference PSD specified at each breakpoint. These high and low alarm limits apply to all spectral lines falling between each particular breakpoint and the next higher breakpoint, including the line which may occur at the specified breakpoint.

Although a new output acceleration PSD is calculated each frame, it is only used once each loop time to generate a new drive voltage PSD. Thus, the acceleration PSD is checked against the alarm limits only once each loop time. An out-of-limit condition is communicated to the host through a status message which appears on the next display. The test, however, continues in a normal manner. The number of spectral lines allowed outside the alarm limits is selectable at test setup.

1.4.3 Spectral Line Abort Limit Checks

Abort limits are defined at test setup in a manner similar to the

alarm limits, and are used to check the values of the output acceleration PSD once each loop time. The number of spectral lines outside the abort limits which are needed to define an out-of-limit condition is selectable at test setup. An out-of-limit condition immediately causes the test to end safely by reducing the output voltage to zero in a short time, but not so short as to generate potentially dangerous transient responses in the test specimen. This action is accomplished within the HSDSP and it is not necessary to wait for communication with the host, although a status message is displayed when the data display is refreshed.

1.4.4 Wideband Acceleration Abort Limits

Two distinct sets of wideband acceleration abort limits are provided. In both cases the abort limits are given in dB relative to the rms acceleration corresponding to the reference PSD.

In the first case, a set of high and low abort limits is established in the test setup. The rms output acceleration is calculated once every loop time from the averaged values of $G_{yy}(f)$, and should the calculated value fall outside the acceptable interval, the drive voltage is ramped to zero. The statistical fluctuation of the rms acceleration determined from the averaged values of $G_{yy}(f)$ is very small, and the abort limits specified in the test setup can therefore be made much smaller than those established for the line abort limits.

For the second case, another set of abort limits is established in the operating program of the 400AT. The rms output acceleration for this set of limits is calculated once every frame time from the values of $G_{yy}(f)$ (Eq 1-3) which are derived directly from the previous frame of input data. While these values separately are not statistically significant estimates of the acceleration PSD, they do provide a statistically significant estimate of the rms acceleration on a frame-by-frame basis, since the calculation involves data from at least 125 lines (Table 1-1).

This frequent calculation of rms output acceleration allows equipment failures such as open or shorted accelerometer cables to be

detected quickly. An out-of-limit condition again causes the drive voltage to ramp to zero in a short time.

1.4.5 Average Control

Any of the eight acceleration input signals may be chosen in any sequence at test setup. An integral and equal number of frames (usually one) of each of the selected control input signals is sequentially time-multiplexed by the AI card of the HSDSP and the resulting signal, y(t), is processed the same as a single control signal would be processed in Fig 1-5.

This technique has been pursued with success for many years with analog and digital control systems. It has been shown in both theory[3] and practice to be accurate in providing a composite control signal whose PSD is the average of the PSD's of the signals that are multiplexed frame by frame. This control technique allows the average of all the input PSD's to be equal to the reference PSD. In the vicinity of specimen resonances, the PSD of some input signals are higher than the reference and others are lower, whereas in bands where no sharp resonances occur, all input PSD's tend to be approximately equal.

A little reflection with the reasoning above shows that the DOF attainable with processing the multiplexed signal with a given frame discount factor K_y (see Eq. 1-18) is equal to the DOF for a single control signal in bands where no shaker-specimen resonances are active. In the narrow frequency bands where about half of the inputs have high PSD's, and the remainder have low PSD's, one would expect the DOF to be about half of the value predicted above because only about half of the input frames are contributing significantly to the data for calculating the FFT. This results in the confidence interval to be only about 40% larger than those in Table 1-3 for these narrow frequency bands.

For instance, with $K_y = 22$, the DOF in a band of frequencies where no resonances occur would be about 100 giving a confidence interval of $\pm$1.0 dB with 90% confidence. In bands near specimen reson-

3. Theron Usher Jr., "Average Control for Sinusoidal and Random Vibration Testing", pp 845-849, JASA, vol 41, No 4 (1967).

ances, the DOF would be about 50, giving a confidence interval of ±1.4 dB with 90% confidence.

1.4.6 Variable Bandwidth Averaging

Variable bandwidth averaging may be used when maximum frequency resolution is required at low frequencies, but less resolution is required at the upper test frequencies. This feature is enabled at test setup. During testing, each of the spectral lines of the acceleration PSD is calculated normally and processed as in Fig 1-5. However, for spectral line alarm and abort checks, as well as for display purposes, the higher frequency spectral lines are first averaged, and then checked. The test frequency range is broken into three different frequency segments. In the higher frequency segments, either 2 or 5 lines may be averaged. Note that variable bandwidth averaging will not provide precise abort checking for abrupt changes in the abort limits at these higher frequencies. Such abrupt changes in abort limits should be avoided when variable bandwidth averaging is to be used. Table 1-4 shows the effective bandwidths with averaging applied for each test frequency segment of the four possible test ranges.

TEST RANGE ft (Hz)	FREQUENCY SEGMENTS (Hz)	TOTAL NO. OF SPECTRAL LINES BEFORE/AFTER AVERAGING		
		125/45	250/90	500/180
2500	Δf - 200	20	10	5
	200 - 1000	40	20	10
	1000 - 2500	100	50	25
1250	Δf - 100	10	5	2.5
	100 - 500	20	10	5
	500 - 1250	50	25	12.5
625	Δf - 50	5	2.5	1.25
	50 - 250	10	5	2.5
	250 - 625	25	12.5	6.25
250	Δf - 20	2	1	0.5
	20 - 100	4	2	1.0
	100 - 250	10	5	2.5
			Hz	

Table 1-4 Spectral Bandwidths after Line Averaging (Hz)

1.4.7 Drive Voltage Signal Clipping

In Fig. 1-5, the final operation for the Output Processor card causes the drive voltage to be clipped at an adjustable level. The test setup allows the operator to select a multiple (2 to 4) of the rms drive voltage at which clipping occurs or to select "no clipping". A choice of "no clipping" effectively places the clipping level at five times the rms value due to the 10 V maximum value and the 2.0 V rms output of the D/A converter on the AO card.

Some tests specify that acceleration peaks shall be limited to three times the rms acceleration (3-sigma). In order to accommodate this specification, the drive voltage is usually clipped at this level or a slightly lower one. The filtering action of the shaker softens the clipping on the acceleration waveform, thus prompting the choice of a slightly lower multiple for drive voltage clipping.

1.4.8 Level Schedule

The level schedule defines a set of amplitude levels to be established in succession during the test and the time intervals associated with each test level. The amplitude levels are specified in dB relative to the maximum level (0 dB) as specified by the Reference PSD. As many as 70 different successive test levels may be specified between -20 dB and 0 dB. A number of successive levels may be repeated a specified number of times. The resulting loops may be contained in larger loops. The maximum time for any single level is 9999 hours, 59 minutes, 59 seconds.

1.4.9 Extremal Control (Option)

The input signals are multiplexed as in average control. However, all input acceleration PSD's are estimated with the specified DOF, and compared at each line frequency. The largest PSD at each frequency provides the control. The individual input PSD's are always less than or equal to the reference PSD, except for statistical fluctuations.

1.5 MODES OF OPERATION

Several basic functional modes of operation exist. The most important are TEST SETUP, RUN TEST, RUN TEST SEQUENCE and TEST DATA. Each may be selected by the operator at the System Host by keyboard entry through a set of menus and prompts. Dedicated function keys are used throughout not only for selection from the menus but for further control within operational modes. The modes are briefly described in the following sections.

1.5.1 Test Setup

By selection of TEST SETUP from the test menu, the operator is able to define the test parameters for a specific test. A tabular form is presented and the operator fills in the form by typing responses at the keyboard. Default conditions are presented wherever possible to quickly prepare for a test run. Acceptable ranges of values are displayed for each appropriate item, and helpful error messages are given when the operator entry is invalid. Following is a summary of the TEST SETUP menu.

TEST SETUP ID: 60 character (max) describing test setup and displayed with the test data graph.

ARMATURE WEIGHT (LB):
LOAD WEIGHT (LB): Required to establish an initial gain estimate for startup purposes.

CONTROL CHANNEL INPUT SEQUENCE: Select one channel from eight inputs for single channel control or select sequence from eight inputs for average control, or extremal control (option).

MAXIMUM ANALYSIS FREQUENCY: Select either 2500, 1250, 625 or 250 Hz.

#LINES/FREQUENCY RESOLUTION: Select 500, 250 or 125 lines. Resolution automatically calculated from previous selection.

REFERENCE SPECTRUM: Enter Breakpoint frequencies, PSD's, alarm and abort values in displayed table. Note that Hanning input windowing limits the accurate measurement and thus control of PSD's having slopes of more than approximately 5-6 dB per unit frequency resolution (line separation).

DEGREES OF FREEDOM (DOF): Select integer from 25 to 400 (see 1.3.4). Confidence interval and K_y are calculated and displayed.

FRAMES/LOOP (L): Select integer from 4 to 43 (see 1.3.2).

NUMBER OF LINES TO TRIGGER ALARM: Select number of out-of-tolerance lines to cause an alarm.

NUMBER OF LINES TO TRIGGER ABORT: Select number of out-of-tolerance lines to cause the test to abort.

VARIABLE/FIXED BANDWIDTH AVERAGING: Variable bandwidth provides checking and displays as described in Section 1.4.6 and Table 1-4.

GRMS ABORT LIMIT (+dB, -dB): Select high and low limits with reference to value for the reference PSD (see 1.4.4).

N-SIGMA DRIVE LIMITER: Select an rms signal multiplier from 2 to 4, or no limiting (see 1.4.7).

ANALYSIS CHANNEL SCALING: Select a value between 0.1 and 1.0 to prevent clipping of the analysis channel signal.

AUTO-RAMPING: Select SLOW, MEDIUM or FAST ramping for drive voltage when starting test initially or whenever returning to the AUTO mode.

MULTIPLE LEVEL TEST: A "no" answer indicates a single level test. A "yes" answer causes the level schedule table to be displayed for the operator entry of test levels and associated duration times (see 1.4.8).

Any test setup may be edited, printed, displayed, deleted or copied after completion. A minimum of 100 test setups may be stored on the hard disk. A list of all test setups may be displayed or printed.

1.5.2 Run Test

After the test setup has been completed, the test may be initiated by selecting RUN TEST from the menu. The operator is prompted for a TEST SETUP ID to select a particular test as well as a TEST RUN NAME to allow for any test setup to be run a number of times with separate data storage and identity for each test run.

At the beginning of each test run a calibration state is entered in which the system transfer function is estimated as described in

Section 1.3.2 at a very low test level. The discrete gain and level scaling stages on the AI and AO boards are set accordingly.

The system is then equalized as described earlier at a level 20 dB below the full reference level. A status summary is reported to the operator after the calibration procedure, and if no problem exists the test continues under closed loop control as defined in the test level schedule.

Several options exist after closed loop control is established such as controlling the test level manually in 1 dB steps, providing open loop testing, and reducing the test level to zero by keyboard action. These are described more fully in the detailed operation procedures.

In the RUN TEST mode, real time data, which includes control and measurement acceleration PSD's, the drive voltage PSD and system transfer function may be displayed, printed in graphical form or stored on hard disk. The graphical display parameters, which are selected automatically by default, may be changed at any time by keyboard action to:

1 - Change the frequency scaling from log to linear.
2 - Change the number of decades and the uppermost decade for the logarithmic vertical scale.
3 - Expand the horizontal frequency scale to include the maximum value for the selected frequency range (250, 625, 1250 or 2500 Hz). Normally only the lowest to highest and frequencies as specified in the reference PSD are displayed.
4 - Provide a "zoom" mode to show more detail between two values of frequency.
5 - To eliminate or provide detail such as alarm limits, abort limits and grid lines for the graphical presentation.

Full annotation is included in each graphical display, and changing graphical displays is easily accomplished from the keyboard by single key operation.

1.5.3 Run Test Sequence

When this mode of operation is selected from the menu, a set of

separate test setups to be executed in sequence is then identified by the operator. The VCS ensures a smooth transition from one test setup to the next. The usual operations of editing and displaying, deleting and copying are provided.

1.5.4 Test Data

The actual TEST DATA mode is entered by selection from the menu. Spectral data from previously run tests can be recovered by supplying a TEST ID and TEST RUN NAME in response to the corresponding prompts. The graphical display parameters for the data stored on the disk may be changed as described in the TEST RUN mode section for appropriate viewing or before printing. Transfer to floppy-disk or deletion are easily accomplished. A list of all test data stored for any TEST RUN and a list of all test runs may be displayed or printed.

1.6 KEY TECHNICAL SPECIFICATIONS

FREQUENCY RANGES: 250, 625, 1250 or 2500 Hz

FREQUENCY RESOLUTION: 125, 250 or 500 lines

CONTROL CHANNELS: 1 to 8 internally multiplexed inputs for single channel, average PSD control, or extremal PSD control (option).

ANALYSIS CHANNEL: Selectable during test from any one of eight input channels.

INPUT SENSITIVITY: 10 mV/g (10 pC/g charge input optional). Automatically ranged and scaled for specified load and test level to provide optimal input voltage at the A/D converter.

A/D CONVERTERS: $\pm$10 V max input, 2 V rms, 12 bit

REFERENCE PSD: As many as 42 amplitude frequency breakpoints. Storage for 100 test setups. PSD programmable from .00001 to 99 g^2/Hz.

CONTROL TOLERANCE: Input PSD controlled to $\pm$1.0 dB of reference PSD with 90% confidence (100 DOF). DOF programmable from 25 to 400. Spectral line alarm and abort limits specified for each segment of reference PSD. Wideband rms acceleration abort tolerances independently specified.

EQUALIZATION TIME: 10 dB error in control PSD equalized to within $\pm$1 dB of reference PSD in six seconds for 100 DOF and 10 Hz resolution (250 lines/2500 Hz range). 100% real time operation.

LEVEL SCHEDULING: Accommodation for as many as 70 different levels from -20 dB to 0 dB (relative to Reference PSD) and their associated test times. Looping or repeating levels provided in test schedule. Changes of test levels are accomplished in one input frame time (500 lines/2500 Hz range = 0.2 sec) without disturbing equalization.

OUTPUT SIGNAL: $\pm$10 V peak, 2.5 V rms max, automatically ranged, scaled, and coupled with ranging and scaling on input amplifier for specified load and test level to pro-

vide optimal output voltage for D/A converter. Gaussian probability distribution. 50 ohms output impedance.

D/A CONVERTER: $\pm$10 V peak, 2.0 V rms, 16 bit, >70 dB dynamic range.

OUTPUT LIMITING: None or selectable from 2 to 4 times the rms drive voltage.

VARIABLE BANDWIDTH: Higher frequency PSD values averaged for 2 and 5 adjacent lines for display and alarm/abort purposes.

OTHER INPUT: External abort input.

GRAPHICS: Full color display; automatic selection of amplitude and frequency scaling. Also log or linear frequency axis, programmable zoom on frequency axis, adjustable log amplitude scales, movable cursor. Displays of control acceleration PSD, measurement PSD, drive voltage PSD, system transfer function with full annotation and display of reference PSD with tolerance limits where applicable.

GRAPHICS ANNOTATION: Direct labeling of amplitude and frequency axes; test identification and description, date, time, test running time, display title, test level, rms acceleration, max frequency, resolution, DOF, input channel multiplexing sequence, operating mode, function of special purpose keys.

HARD COPY: Dot-matrix printer, screen display rotated 90^{o} for full use of 8-1/2 x 11 paper for display copy.

HARDWARE: Unholtz-Dickie High Speed Digital Signal Processor UD320, IBM Personal Computer AT Enhanced; IBM 13 inch diagonal Enhanced Color Monitor and Enhanced Graphics Adaptor; Dot-Matrix Printer; Keyboard; IEEE488 Interface.

2. INSTALLATION - INTERCONNECTIONS

2.1 Preliminary

Unpack the separate items carefully, taking care not to damage any items or lose any small items. It would be advantageous to save the shipping containers should any items need to be shipped to the factory during the warranty period.

The following items should be available after unpacking:

(1) UD Model 320 HSDSP (400AT/R, 400AT/T)
(2) UD Model 340 SINE CONTROL (400AT/S only)
(3) IBM PC AT Enhanced (5170) or UD-supplied PC AT Compatible Host Computer
(4) Metrabyte Dascon 1 Interface for PC AT (400AT/S only)
(5) IBM Model 5154 or UD-supplied color Video Monitor
(6) Keyboard for Host Computer
(7) Dot Matrix Printer - Okidata Microline 192, Star SG-10, Star Delta 15+, HP Thinkjet or Panasonic
(8) Signal Cable for Printer (25 pin, D connector)
(9) IEEE-488 Signal Cable (400AT/R, 400AT/T)
(10) 37 pin Signal Cable (400AT/S only)
(11) Removable power cords for the Host Computer, Video Monitor, and Printer
(12) Mounting Cabinet (optional)

Before making electrical connections, arrange the various items in the Mounting Cabinet. The printer is placed in the sound-proofed upper compartment for the 400AT/R and 400AT/T. The Host Computer is placed on the shelf below the upper compartment, and the Video Monitor, on top of the Host. The keyboard is placed on the desk top which moves in and out of the cabinet just below the Host Computer. The UD320 HSDSP can be placed on the shelf just below the keyboard.

For the combined 400AT/R and 400AT/S VCS, see Fig. 2-3 for recommended cabinet mounting.

2.2 Power Connections

Connect the removable power cords to the UD320, UD340, Host Computer, Video Monitor and Matrix Printer, and plug the other end of each into the line power receptacle (115 VAC) mounted inside the Mounting Cabinet. The user may want to purchase and install a power line surge protector at this point.

The user may also desire to apply power to the 400AT through the vibration power amplifier console, by plugging the line power cord from the common receptacles inside the Mounting Cabinet to a line power receptacle inside the UD system console. This allows line power to be applied when the POWER ON button is pushed on the Power Amplifier Control Panel. This step should be done last however, as a number of signal interconnections still have to be made.

Check the line voltage switches on the rear panels of the UD320, UD340 and the Host Computer, and also the specifications on the rear panels of the printer and Video Monitor to make sure that they agree with the line voltage being supplied (usually 105-125 VAC 50-60 Hz).

2.3 Signal Interconnections - Host Computer

Make the following signal interconnections where applicable:

(1) The keyboard is connected to the Host Computer via a cable with a 5 pin circular connector and a mating connection on the rear of the Host Computer. When the pins are appropriately mated, push the connector in about 1/2 inch.

(2) (400AT/R, 400AT/T) The Host Computer is connected to the UD320 HSDSP via the IEEE-488 cable with a 24 pin male ribbon connector on each end. The IEEE-488 port is labeled on the rear panel of the UD320 and is in connector slot 4 on the rear panel of the Host Computer. Tighten the two locking screws on each connector housing after mating.

(3) The integral signal cable on the Video Monitor has a 9 pin male D style connector which mates to the connector in slot 1 on the rear of the Host Computer. Tighten the locking screws with a small screwdriver.

(4) The printer cable may or may not be integral with the printer, depending on the printer model. The 25 pin male D style connector mates with the connector in slot 5 on the rear of the Host Computer. Tighten the locking screws with a small screwdriver.

(5) (400AT/S) The Host Computer is connected to the UD340 SINE CONTROL via the cable with a 37 pin D-style female connector on each end. The port on the rear panel of the UD340 is labeled J1 and the corresponding port on the rear of the Host Computer is in connector slot 7. Tighten the two locking screws on each connector housing after mating.

2.4 Signal Interconnections - UD320 HSDSP-UD340 Sine Control

Refer to Fig. 2-1 which shows the rear panel of the UD320 HSDSP. On the right-hand side of the panel are the eight acceleration input connections of the 400AT System.

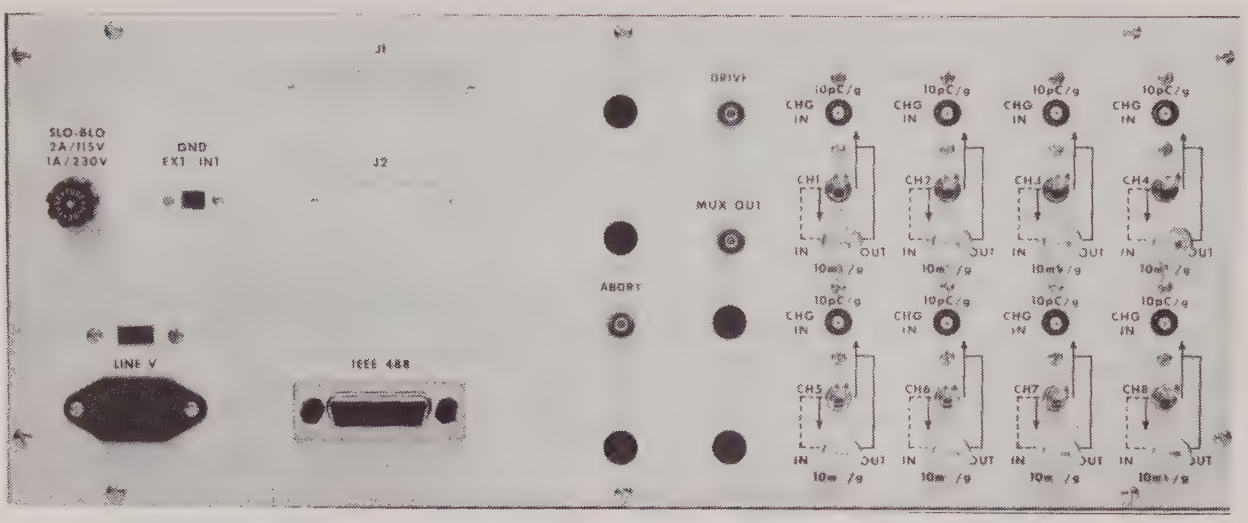


Fig. 2-1 Rear Panel - Model UD320 HSDSP

Refer to Fig. 2-2 which shows the rear panel of the UD340 SINE CONTROL. Near the middle of the panel are the eight acceleration input connections of the 400AT/S System, when the average control option is supplied.

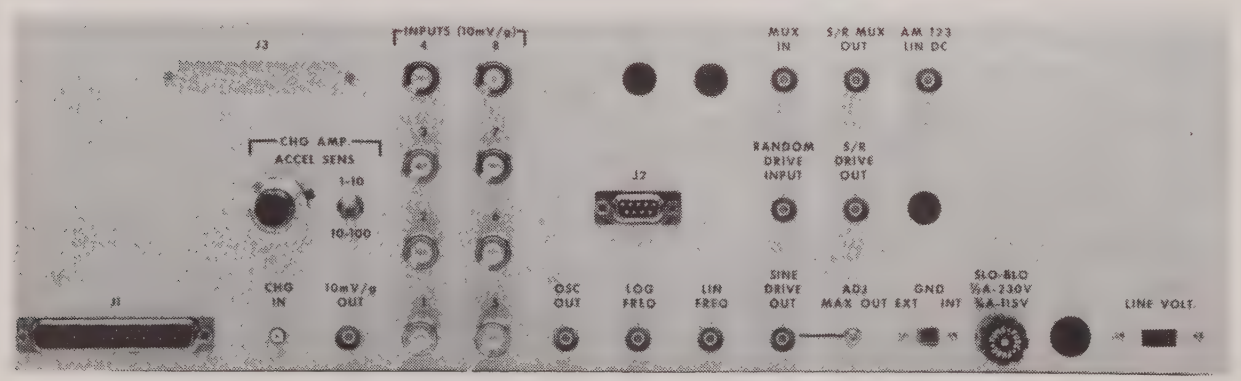


Fig. 2-2 Rear Panel - Model UD340 SINE CONTROL

For the UD320 in Fig. 2-1:

With the locking toggle selector switches in the down position, the insulated BNC connectors accept input signals from external (acceleration) signal conditioners at a sensitivity of 10 mV/g. Those BNC connectors not connected via coaxial cable to signal conditioners must have the associated shorting caps seated securely over the unused connectors.

If the internal charge converter option has been supplied with the UD320, insulated miniature 10-32 connectors appear through the holes just above the locking toggle selector switches. To make the 10-32 connectors active for charge inputs, the toggle switches must be in the up position. Noise-treated cable connections may then be made between these connectors and piezoelectric accelerometers having no internal electronics and calibrated sensitivities of 10 pC/g(±2%). A good accelerometer selection is the UD 10B10(T). The lower BNC connectors can now be used as output connectors, supplying conditioned signals at 10 mV/g with an output impedance of 50 ohms. For this alternative, those input channels with no accelerometers connected to the upper charge inputs, must have the shorting caps securely seated on the lower BNC connectors.

Connect the signal from DRIVE to the input connector of the power amplifier via a coaxial cable with BNC connectors. If the UD340 is also supplied, connect DRIVE (UD320) to RANDOM DRIVE INPUT (UD340). Then connect S/R DRIVE OUT (UD340) to the power amplifier input.

The MUX OUT connector (BNC) provides a buffered, time-division-multiplexed version of the input signals according to the TEST SETUP specifications. It is primarily intended to provide an input signal for the UD Model AM-123 Vibration Monitor/Limiter, for parallel system protection.

The ABORT input connector (BNC) accepts an external TTL abort signal for which a TTL-low signal or shorting of the center conductor to the shell causes an ABORT command to the vibration control system. Connect as desired.

The IEEE 488 connection was mentioned in Section 2.2. J1 is a cutout for an optional 37-pin D style connector for a remote interface. J2 is intended for possible future use.

For the UD340 in Fig. 2-2:

The eight insulated BNC connectors near the center of the rear panel accept input signals from external (acceleration) signal conditioners at a sensitivity of
10 mV/g. Those BNC connectors not connected via coaxial cable to signal conditioners must have the associated shorting caps seated securely over the unused connectors. If the UD320 is also supplied with the internal charge converter options, the 10 mV/g output connectors of the UD320 can be connected to the 10 mV/g input connectors of the UD340.

One internal charge amplifier is supplied with the UD340. It will accept a signal input through a noise-treated coaxial cable from a piezoelectric accelerometer at the miniature 10-32 CHG IN connector. The accelerometer sensitivity in pC/g is set on the potentiometer and range switch above the CHG IN connector. The 10 mV/g OUT connector then supplies a conditioned signal at the standardized sensitivity.

The 10 mV/g OUT signal may be connected externally to one of the INPUT connectors. (Usually Channel 1 for the control input.)

Connect the signal from DRIVE OUT to the input connector of the power amplifier via a coaxial cable with BNC connectors. If the UD320 is also supplied, use the S/R DRIVE OUT to connect the drive signal to the power amplifier, as explained earlier.

The OSC OUT and LIN FREQ signals are used if tracking filters (UD Model TF22) are necessary to filter the 10 mV/g acceleration input signals.

As explained previously, J1 is used for a cable connection to the Host Computer with the Metrabyte Dascon 1 interface card.

The MUX OUT and the AM123 DC connectors supply signals to the AM123 for parallel system protection. Newer Model UD340 incorporates a switching arrangement to supply automatically the proper MUX OUT signal from either the UD320 or UD340 for random or sine operation.

See Fig. 2-4 for a connection diagram involving the UD320 and UD340 for both sine and random operation.

2.5 Final Check

Make sure that all connections have been properly made between the Host Computer, Printer, Keyboard, Video Monitor, UD320 and UD340. Then check the connections made from the control accelerometers to the signal conditioners (if necessary) and the UD320/UD340, and also from the UD320/UD340 to the power amplifier. All power cords should be inserted into outlet boxes. Finally, the power cord from the Mounting Cabinet for the Host Computer should be connected to an outlet strip inside the system console.

At this point you can begin Chapter 3. A.C. power to the Mounting Cabinet can be turned on by pressing the PREAMP ON button for the UD System Console. Heed the following warning:

WARNING

It should be noted that the power to the UD320 HSDSP or UD340 SINE CONTROL should NOT be applied or removed when the power amplifier is turned on and the gain is turned up. With the power cords connected as suggested earlier, this should not be possible unless the operator toggles the UD320 power switch.

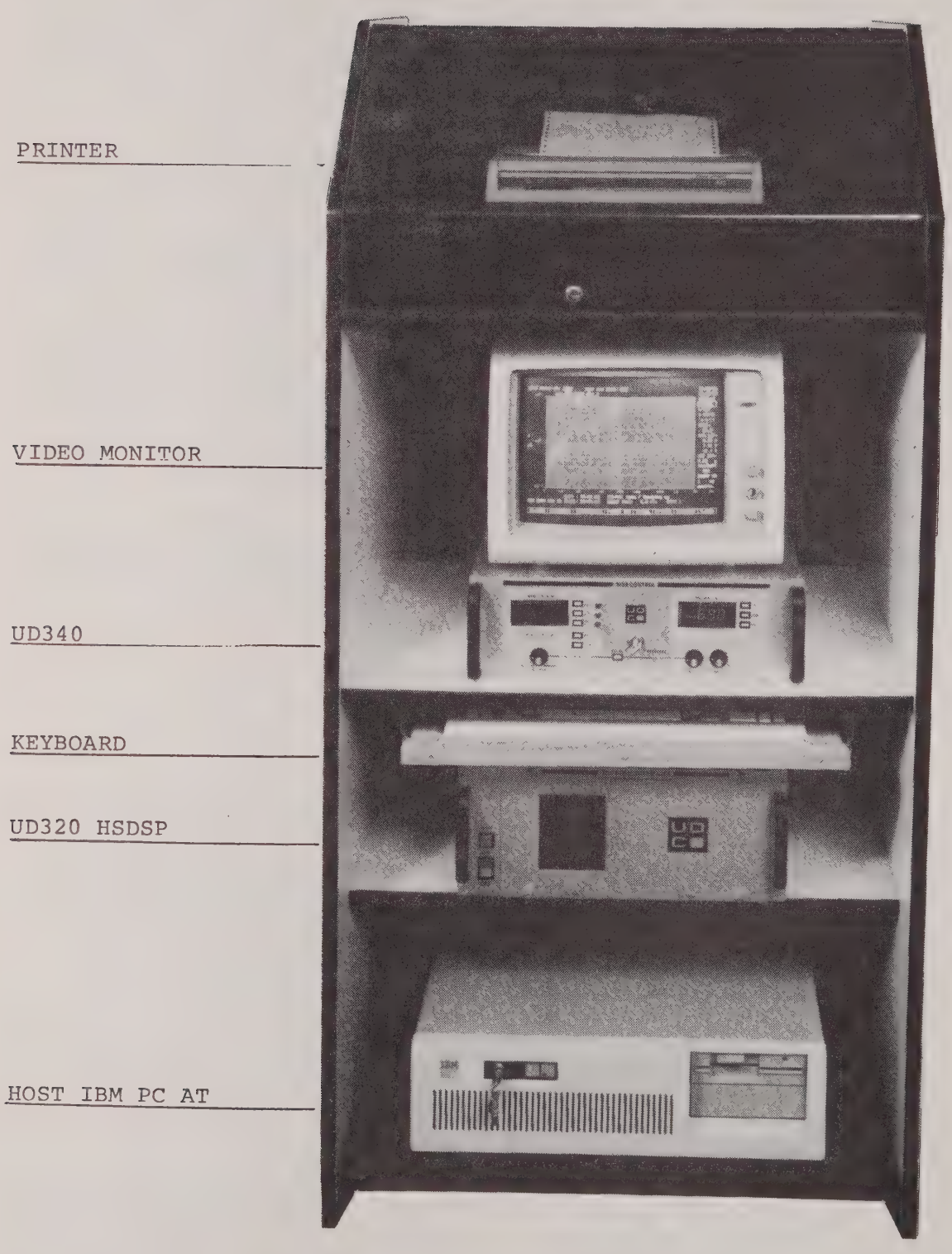


Fig. 2-3 Combined Random and Sine Controls in Mounting Cabinet
Note that the divider in the bottom of the cabinet has been removed.

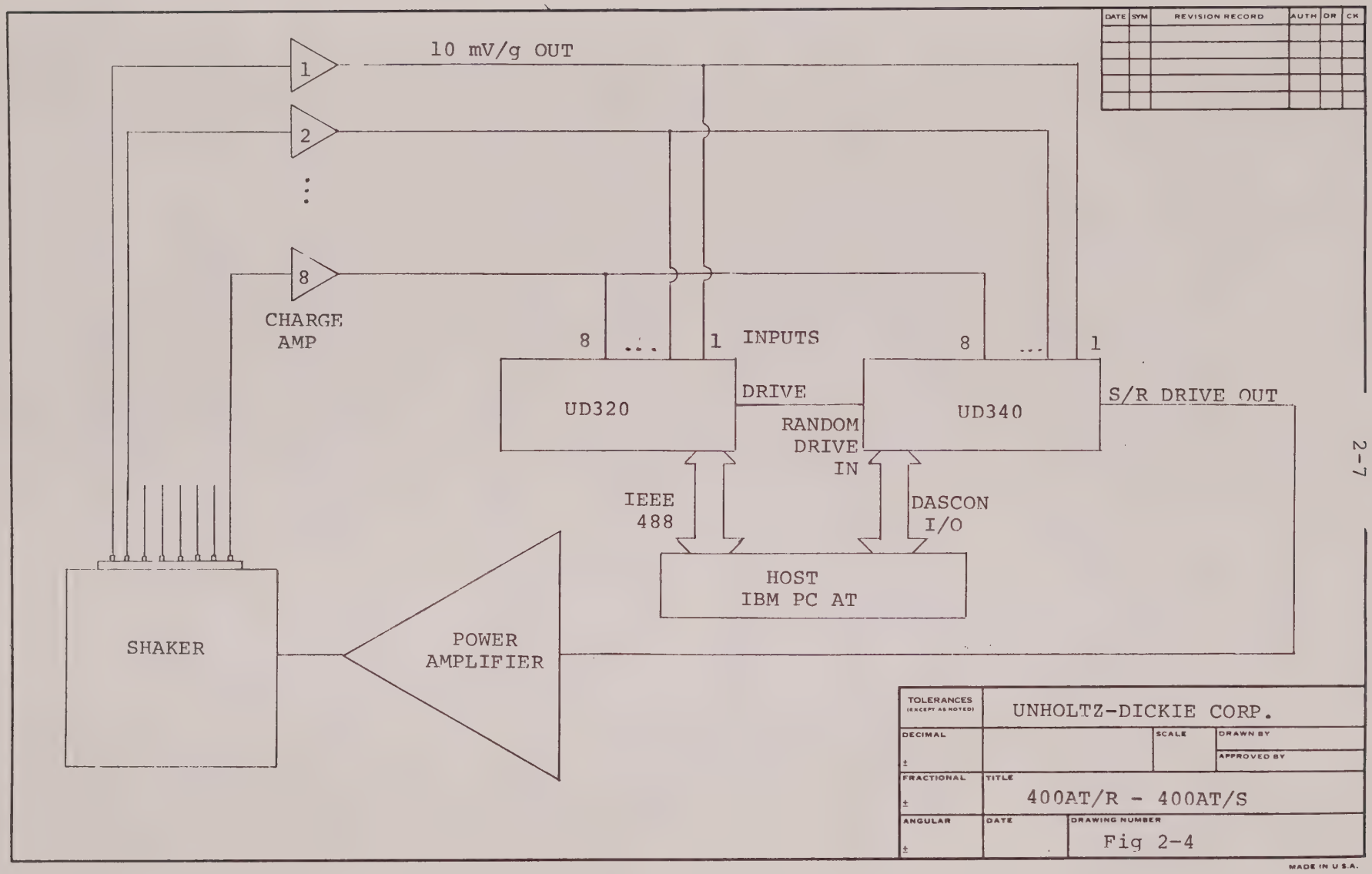


Fig. 2-4 Connections for Combined Sine and Random System

3. PRELIMINARY SYSTEM OPERATION

3.1 Introduction

The U-D Model 400AT is extremely user-friendly, being extensively driven by responses to menus and requests appearing on the screen of the color monitor. All responses are entered on the keyboard of the host computer. In this chapter the operator is taken on a guided tour through the various menus and test description procedures. Practically all of the procedures need little additional description because operator requests for help cause explanative text to be displayed on the color monitor.

3.2 Initial Procedure

Make sure that the installation procedures described in Chapter 2 have been completed successfully. Actually, it is not necessary at this time that the system power amplifier be turned on, since all procedures in this chapter stop short of initiating a drive signal to the power amplifier from the UD320 HSDSP (Random and Transient control) or from the UD340 (Sine control).

Turn the monitor on by turning the upper knob clockwise. The middle knob adjusts the background level of test graphs displayed on the monitor. The lower knob adjusts the brightness of the display.

Turn on the line printer power switch. Make sure the SELECT indicator is lighted. Press the SELECT button if it is not. Turn on the power switches of the UD320 HSDSP, UD340 SINE CONTROL and the host computer.

The host computer proceeds through some initial internal checks and in less than a minute, the system logo is automatically displayed on the montior, a copy of which is shown on p. 3-3. The guided tour is almost ready to begin.

3.3 System Keyboard

The most common system keyboard is shown in Fig. 3-1. A top block of 12 keys, (F1) through (F12), are called FUNCTION KEYS. These keys are used to make entries from system menus and to control system operation when the vibration test is actually in progress.

The large block of keys contains the standard typewriter keyboard as well as three special purpose keys: (Ctrl), (Alt) and (Enter). The (Enter) key is used by the operator to confirm responses to queries appearing on the monitor. Numerical entries are most conveniently made from the keyboard since they are all lower case.

The CONTROL KEYS are (Esc)- escape, (End), (Ins)- insert, (Del)- delete, (PgDn)- page down, (PgUp)- page up, (PrtSc)- print screen, and the four cursor movement arrows. Some of these single-action keys are duplicated in the right-hand block, which contains

numbers as upper case entries. Numerical entries from the right-hand block are not recommended, since a (Shift) omission can cause an unwanted control key command.

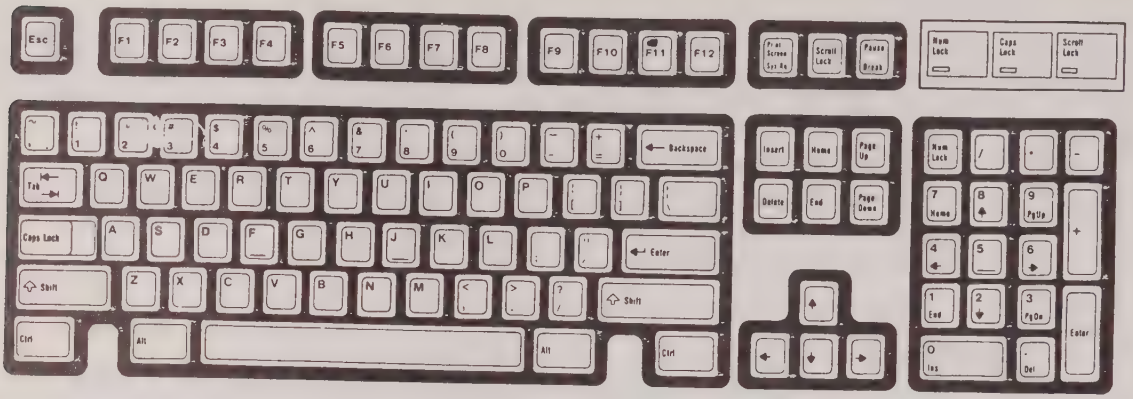


Fig. 3-1 Common System Keyboard

A less-common keyboard is shown in Fig. 3-2. It contains only ten FUNCTION KEYS, and the CONTROL KEYS are lower case entries on the right-hand pad except for (PrtSc), which is upper-case, and requires a simultaneous (Shift) entry.

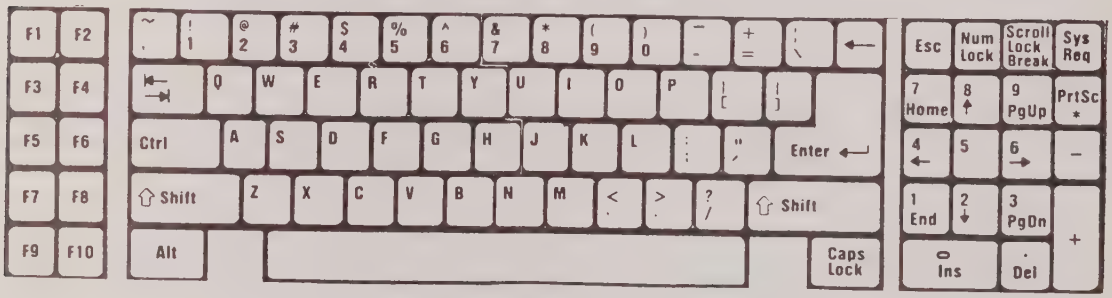


Fig. 3-2 Alternate System Keyboard

3.4 Important Special Commands

The (PrtSc) command causes the line printer to print only text appearing on the screen. It must not be used to print graphical displays introduced in following chapters. The (PrtSc) command was used to print the menus and HELP displays shown on the following pages.

Should any unusual action result in a situation for which the FUNCTION and CONTROL keys seem to be inoperative, press (Ctrl,Alt,Del) simultaneously. This will cause the monitor to go blank, and the host will repeat its initial self-checking action, with the System Logo on p. 3-3 reappearing.

YOU SHOULD NOW BE READY TO START THE PRELIMINARY GUIDED TOUR OF THE 400AT. Start on p. 3-3.

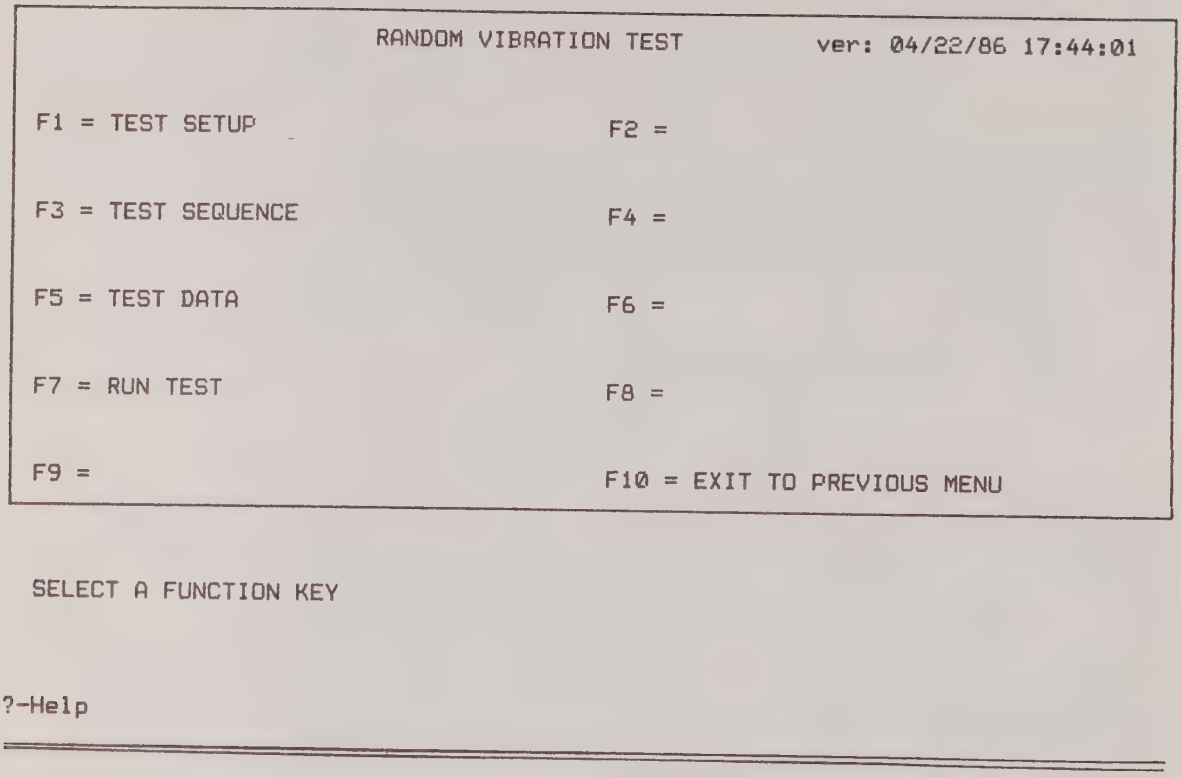
Following successful completion of Section 3.2, we find the System Logo and accompanying message displayed on the Monitor:

```
                        UNHOLTZ-DICKIE



                        MODEL  400AT

                    DIGITAL VIBRATION CONTROL SYSTEM

     You may use the Model 400AT Digital Vibration Controller host software
and the UD320 Signal Processing software, as well as  all associated printed
materials under the terms of the UNHOLTZ-DICKIE Program License Agreement.
In summary UNHOLTZ-DICKIE grants you, as part of the price you paid for
this product, a non-transferrable personal license to use the standard system
software package (and options purchased) on a single Model 400AT unit.
You do not become the owner of the system software package nor do you have
the right to copy, transmit, or alter the software or the related printed
materials. You are legally accountable for any violation of the License
Agreement and Copyright laws.
                    Copyright (c) 1986 by Unholtz-Dickie Corp
ver 2.00s    05/30/86        09:29:58
PRESS any KEY to ASSENT to the License Agreement and proceed with the program
```

Pressing any key displays the MAJOR OPERATIONAL MODES Menu below:

```
                    MAJOR OPERATIONAL MODES

F1 = RANDOM TEST                    F2 = REMOTE/LOCAL

F3 = SINE TEST                      F4 = MEASUREMENT/ANALYZE

F5 = SINE ON RANDOM TEST            F6 = MAINTENANCE/DIAGNOSTICS

F7 = SHOCK TEST                     F8 = HELP

F9 = RANDOM ON RANDOM TEST          F10 = EXIT

  SELECT A FUNCTION KEY
```

Press (F1) to display the RANDOM VIBRATION TEST Menu on p.3-4. Selection of (F10) would display the System Logo again.



Press (Shift,?) simultaneously to obtain the HELP display shown on p. 3-5. These offer further explanation of the FUNCTION KEYS.

Note that all possible CONTROL KEY selections are shown at the bottom of each display, as well as other instructions.

RANDOM VIBRATION TEST MENU (pg 1)

All key selections display new menus except F7.

F1 - TEST SETUP - A test setup is the specification and entry of all test parameters. This menu allows various operations with saved test setups as well as creation of new setups.

F3 - TEST SEQUENCE - A test sequence is a group of test setups which run automatically in the listed sequence. The menu allows various operations with a saved test sequence as well as creation of a new sequence.

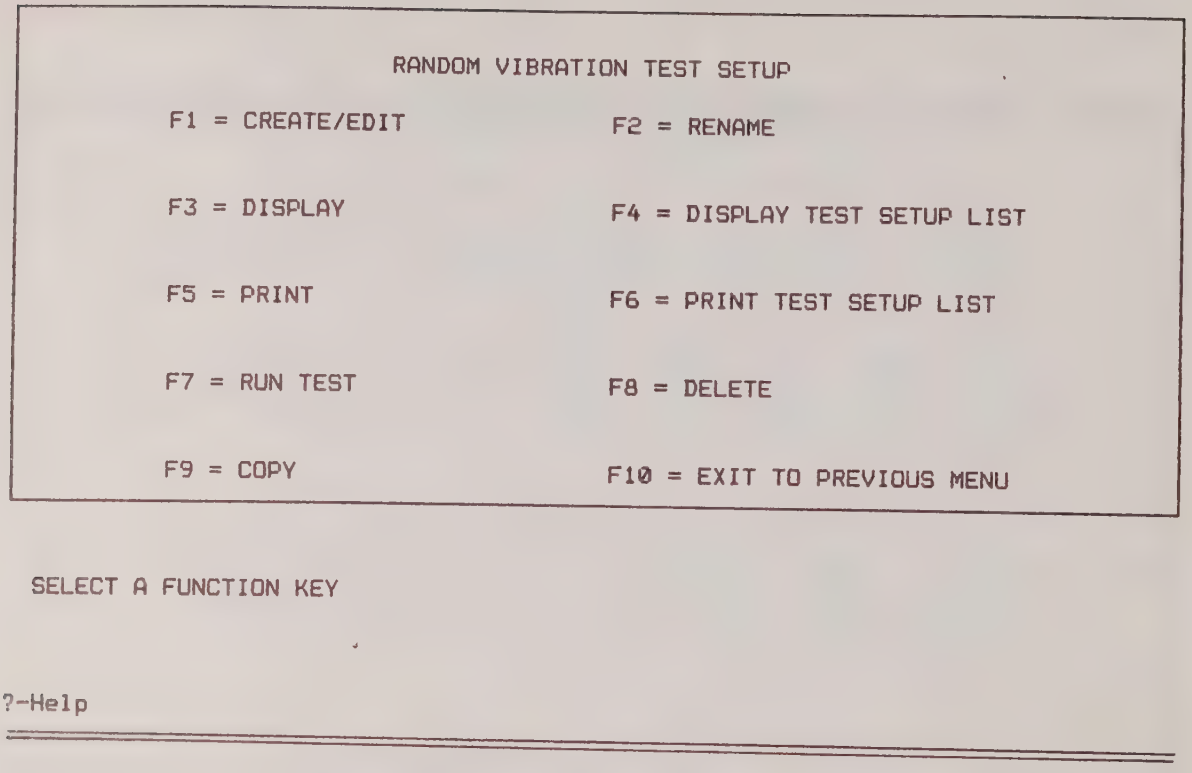
F5 - TEST DATA - Menu allows various operations with saved test data.

F7 - RUN TEST - Allows a test to be started. The first default entry is the most recently saved test setup. This entry may be overwritten with any other saved test setup ID. Two additional default entries may also be overwritten to initiate the test.

Esc - back to menu

Press (Esc) to return to RANDOM VIBRATION TEST Menu on p. 3-4.

Press (F1) to display RANDOM VIBRATION TEST SETUP Menu on p.3-6.



Press (Shift,?) to obtain HELP displays on p.3-7.

RANDOM VIBRATION TEST SETUP MENU

Default entry for F1,F3,F5 and F7 is the most recently saved test setup. It may be overwritten with another entry.

F1 - CREATE/EDIT - Creates a new setup or allows changes to an existing one.

F2 - RENAME - Changes the ID for an existing test setup to a new ID.

F3 - DISPLAY - Displays the setup parameters including a graph of the reference PSD. No changes can be made in this mode.

F4 - DISPLAY TEST SETUP LIST - Displays a list of all existing test setups sorted alphabetically, with the time and date that each was created or last updated.

F5 - PRINT - Prints the setup parameters for an existing test setup.

F6 - PRINT TEST SETUP LIST - Prints a list of all existing test setups sorted alphabetically, with the time and date that each was created or last updated.

PgDn - to continue Esc - back to menu

Press (PgDn) to display HELP (pg.2) below:

RANDOM VIBRATION TEST SETUP MENU (pg 2)

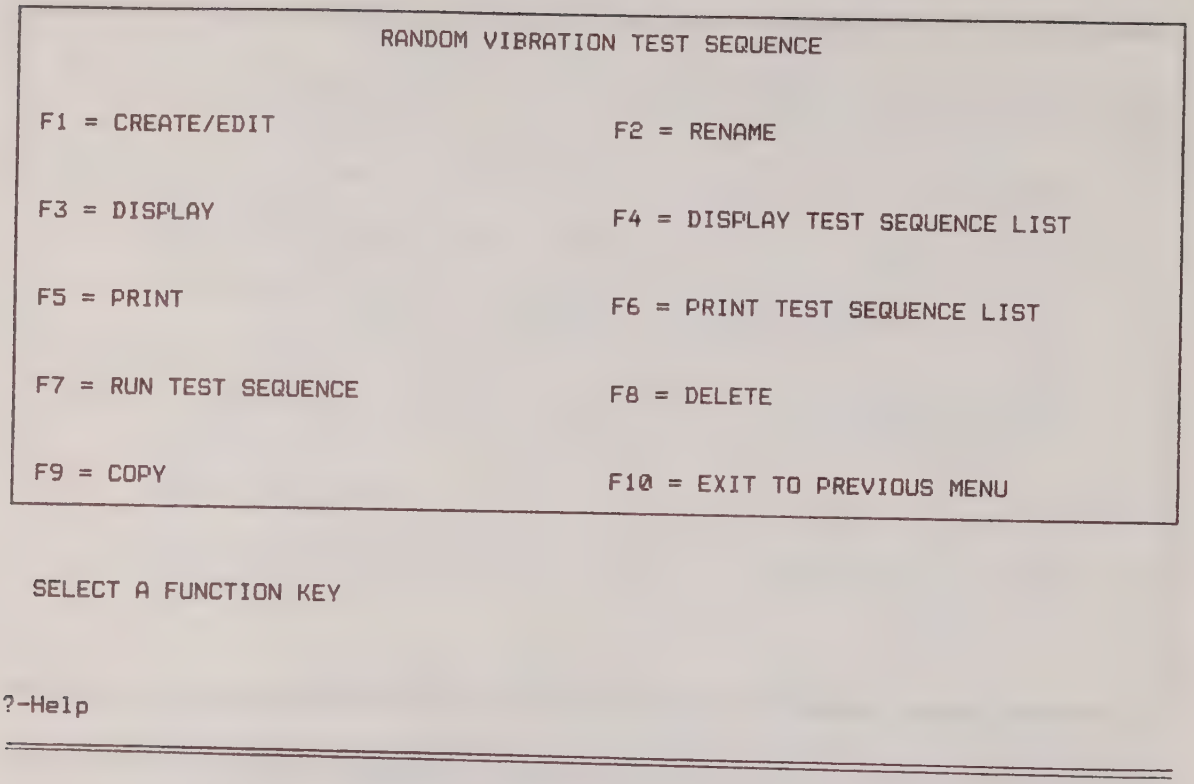
F7 - RUN TEST - Initiates the identified test. The remaining two default entries displayed may also be overwritten.

F8 - DELETE - Deletes the specified test setup from the hard disk

F9 - COPY - Makes a copy of an existing test setup with an new ID, and does not change the original setup and its ID.

PgUp - back up one screen Esc - back to menu

Press (Esc) to return to R.V. TEST SETUP Menu on p.3-6.
Press (F10) to return to R.V. TEST Menu on p.3-4.
Press (F3) to display R.V. TEST SEQUENCE Menu on p.3-8 following:



Press (Shift,?) to display HELP pages on p.3-9

Note that there is a hierarchy of test operations. On the highest or most complicated tier there is the TEST SEQUENCE which involves a number of TEST SETUPS. Each TEST SETUP involves a number of individual TEST RUNS, the data for which may or may not be saved.

The R.V. TEST SEQUENCE Menu involves the same kinds of operations as those shown on the TEST SETUP Menu (See p.3-6).

RANDOM VIBRATION TEST SEQUENCE MENU

Default entry for F1, F3 and F5 is the most recently saved test sequence. It may be overwritten with another entry.

F1 - CREATE/EDIT - Creates a new test sequence or allows changes to an existing one.

F2 - RENAME - Changes the ID for an existing test sequence to a new ID. The initial ID is deleted.

F3 - DISPLAY - Displays information for an existing test sequence. No changes can be made in this mode.

F4 - DISPLAY TEST SEQUENCE LIST - Displays a list of all existing test sequences sorted alphabetically with the time and date that each was created or last updated.

F5 - PRINT - Prints information for an existing test sequence.

PgDn - to continue Esc - back to menu

Press (PgDn) to display HELP (pg.2) below:

RANDOM VIBRATION TEST SEQUENCE MENU (pg 2)

F6 - PRINT TEST SEQUENCE LIST - Prints a list of all existing test sequences sorted alphabetically, with the time and date each was created or last updated.

F7 - RUN TEST SEQUENCE - Initiates an existing test sequence.

F8 - DELETE - Deletes the specified test sequence from the hard disk.

F9 - COPY - Makes a copy of an existing test sequence with a new ID and does not change the original sequence and its ID.

PgUp - back up one screen Esc - back to menu

Press (Esc) to return to R.V. TEST SEQUENCE Menu on p.3-8.
Press (F10) to return to R.V. TEST Menu on p.3-4.
Press (F5) to display the RANDOM VIBRATION TEST DATA Menu on p.3-10.

```
                    RANDOM VIBRATION TEST DATA

F1 =                                    F2 =

F3 = DISPLAY TEST GRAPH                 F4 = DISPLAY TEST RUN LIST

F5 =                                    F6 = PRINT TEST RUN LIST

F7 = DELETE TEST DATA                   F8 =

F9 =                                    F10 = EXIT TO PREVIOUS MENU

 SELECT A FUNCTION KEY

?-Help
```

Press (Shift,?) to display the HELP page below:

```
                RANDOM VIBRATION TEST DATA MENU

F3 - DISPLAY TEST GRAPH - Allows operator to view test PSD's and transfer
     functions that were stored during a test run. The two default entries
     are the test setup ID and test run name for the most recently saved
     data. They may be overwritten.

F4 - DISPLAY TEST RUN LIST - Displays the list of test setups and run names
     associated with each setup. The date and time the setup was last
     edited and the date and time the data was stored is also displayed.

F6 - PRINT TEST RUN LIST - Prints the test run list information displayed
     by F4.

F7 - DELETE TEST DATA - Allows entry of the test setup ID and test run name
     to remove the corresponding stored data from the hard disk.

                        Esc - back to menu
```

Press (Esc) to return to R.V. TEST DATA Menu above.
Press (F10) to return to R.V. TEST Menu on p.3-4.
Press (F7) to obtain RUN TEST entries on p.3-11.

The R.V. TEST Menu remains, and the three default entries for the RUN TEST command appear below the Menu in the display below. If these three entries were satisfactory, the operator would press (Enter) three times to confirm the entries and thus begin the TEST RUN. The NAME of the TEST RUN is updated after each TEST RUN (i.e. from RUN213 to RUN214) so that is frequently unnecessary to change the TEST RUN NAME.

At this point, however, follow the instructions below.

```
                        RANDOM VIBRATION TEST          ver: 05/01/86 06:21:01

F1 = TEST SETUP                          F2 =

F3 = TEST SEQUENCE                       F4 =

F5 = TEST DATA                           F6 =

F7 = RUN TEST                            F8 =

F9 =                                     F10 = EXIT TO PREVIOUS MENU

RUN TEST SETUP-ID :..............) DEMOTEST
SAVE TEST DATA :.................) 3
    (1=END OF TEST ONLY,2=PERIODICALLY,3=NONE)
TEST RUN NAME (25 char max) :.....) RUN213

    Esc (Back to Menu)      Enter (Accepts Entry)
```

The flashing cursor is under the first symbol of the TEST SETUP ID.

Press (Enter), and the cursor advances under the (3) of the next entry.

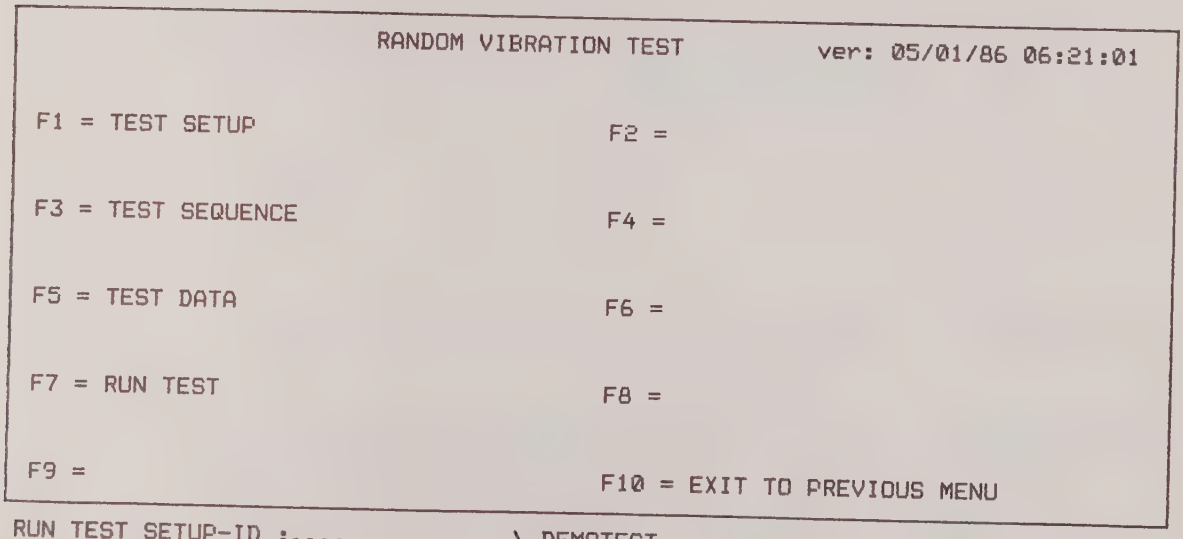
As a further commentary at this time, no attempt is made to overwrite the default entry for the TEST SETUP ID because we have no way of knowing the ID's for other saved test setups. This apparent difficulty is solved later.

We will now practice overwriting a default entry. Follow the instructions on p.3-12, which follows.

With the flashing cursor under the (3), type (2) from the central keyboard.

Press (Enter). The (2) remains, and the cursor automatically moves under the first symbol of the TEST RUN NAME. It is not necessary to overwrite the NAME unless special identification is required.

Press (Enter), thus confirming the default NAME.



The HOW OFTEN query appears automatically when periodic data saves are requested.

Type (Ø) for HOURS, and press (Enter).

Type (Ø) for MIN, and press (Enter).

Type (3Ø) for SEC, and DO NOT press (Enter).

Executing a TEST RUN will be completed in Chapter 4.

Press (Esc) and the information below the Menu disappears.
Press (F1) and the R.V. TEST SETUP Menu appears. See p. 3-13.

Press (F1), causing the default entry for the TEST SETUP ID to appear below the Menu.

```
                    RANDOM VIBRATION TEST SETUP

      F1 = CREATE/EDIT                F2 = RENAME

      F3 = DISPLAY                    F4 = DISPLAY TEST SETUP LIST

      F5 = PRINT                      F6 = PRINT TEST SETUP LIST

      F7 = RUN TEST                   F8 = DELETE

      F9 = COPY                       F10 = EXIT TO PREVIOUS MENU
```

```
 CREATE/EDIT TEST SETUP ID (8 char max)  : DEMOTEST
SPACE AVAILABLE FOR 3688 SETUPS
     Esc (Back to Menu)      Enter (Accepts Entry)
```

We are going to examine the parameters necessary to describe a TEST SETUP, and the means for entering them and changing them.

As a further commentary on the procedure followed on pp.3-11 and 3-12, note that the (F7)= RUN TEST choice again appears on the Menu above. However, we now have a means to determine TEST SETUP ID's other than the default entry by pressing (F4) or (F6).

Return to the display above. The flashing cursor is under the first symbol of the default entry. We now have three choices:

1- To create a new TEST SETUP, type a new ID.
2- To examine and possibly edit another saved TEST SETUP, type the corresponding ID.
3- To examine and possibly edit the last saved TEST SETUP, do not change the entry above.

We will follow the third choice.

Press (Enter), and the first page of line items for specifying the selected TEST SETUP is displayed as shown on p.3-14.

If a new TEST SETUP is created, many line items have default entries to speed the setup process. These may be overwritten.

The flashing cursor appears below the first symbol for the TEST DESCRIPTION. Practice moving the cursor with the directional CONTROL KEYS. See HELP (pg. 3) on p. 3-15.

```
                        RANDOM TEST SETUP

TEST ID :  DEMOTEST                          Last Changed : 05/07/86 09:27:30

TEST DESCRIPTION : UD560 SHAKER WITH 160LB MASS AND RESONANT BEAM LOAD.

ARMATURE WEIGHT  (LB) : ..............)45.0

LOAD WEIGHT      (LB) : ..............)160.0

CONTROL CHANNEL INPUT  SEQUENCE : ...)1,2,3, , , , ,
 (N=CHN FOR N=1-8)

MULTIPLE CHANNEL CONTROL STRATEGY : .)1
 (1=AVG,2=EXTREMAL)

MAXIMUM ANALYSIS FREQUENCY : .........)4
 (1=250Hz,2=625Hz,3=1250Hz,4=2500Hz)

#LINES/FREQ RESOLUTION : .............)3
 (1=125/20Hz,2=250/10Hz,3=500/5Hz)

CONTROL KEYS Esc Enter     End     PgDn     (-          -)          ?-Help
```

Press (Shift, ?) to display HELP (pg.1) below:

```
                TEST SETUP LINE ITEM DESCRIPTIONS ( pg 1 )

  TEST DESCRIPTION - A one line ( 60 character maximum ) description of the
      Test Setup.

  ARMATURE WEIGHT - Enter shaker armature weight in pounds.

  LOAD WEIGHT - Enter total moving weight attached to shaker table in pounds.
      This includes any test fixture, specimen, slip table etc. This and the
      armature weight are used to establish an initial system gain estimate
      and low level start up parameters.

  CONTROL CHANNEL INPUT SEQUENCE - Select one of the eight input channels if
      single channel control is desired. Select any sequence of the eight
      input channels if average or extremal control is desired. For average
      control, specifying one of the input channels more than one time in the
      input sequence will cause its weighting to be proportionately higher
      than the other channels appearing only once.




        PgDn - to continue      Esc - back to menu
```

Press (PgDn) to display HELP (pg.2) on p. 3-15.

The HELP page below completes the explanation of the line items on p.3-14.

TEST SETUP LINE ITEM DESCRIPTIONS (pg 2)

MULTIPLE CHANNEL CONTROL STRATEGY - Select average or extremal control if more than one channel was specified in the input sequence.
AVERAGE CONTROL - The average of the PSD's for the selected input channels is controlled to be equal to the reference PSD.
EXTREMAL CONTROL - The PSD's for each input channel specified are compared at each spectral line frequency and the maximum values are controlled to be equal to the reference PSD. Note that the response time for extremal control is longer than that for single channel or average control, since the PSD's for several channels have to be calculated serially before they are compared.

MAXIMUM ANALYSIS FREQUENCY - Select the frequency range which will include the highest frequency of the desired reference PSD.

#LINES/FREQ RESOLUTION - Select the number of lines to determine the desired frequency resolution:
resolution = (maximum frequency)/(number of lines).

TEST SETUP CONTROL KEYS on next page

PgUp - back up one screen PgDn - forward one screen Esc - back to menu

Press (PgDn) for HELP (pg.3), which describes CONTROL KEY action.

TEST SET UP CONTROL KEYS (pg 3)

Esc - Exits the setup without recording changes. A "Y" answer to the subsequent prompt verifies that this is the true intent of the operation. A "N" answer cancels the Esc command.

Enter - Moves the cursor to the next entry in the setup list and displays the next page of the list if necessary.

End - Saves all setup entries on the hard disk and then returns to the Test Setup Menu

PgDn/PgUp - Moves to the next/previous page of the setup.

↑↓ - Moves the cursor to the entry above/below it.

(- - Moves the cursor one character to the left. If the cursor is on the first position of an entry it is moved to the first position of the entry to the left.

-) - Moves the cursor one character to the right.

PgUp - back up one screen Esc - back to menu

Press (Esc), then (PgDn) to display the next page of TEST SETUP line items. See p.3-16.

You may want to practice editing entries below. If you make an illegal entry, a flashing error message will generally appear.

```
                        REFERENCE PSD ( 0 dB )

 REFERENCE PSD DEFINITION : 1
     (1=BREAKPOINT TABLE ENTRY,2=TEST DATA PSD,3=ANALYZED DATA PSD)

 1) LOWEST REFERENCE PSD FREQUENCY (Hz) : 20.00

   INITIAL SLOPE (dB/OCT) : 3        OR    FIRST LEVEL (GSQR/Hz) :

   HIGHEST REFERENCE PSD FREQUENCY (Hz) : 2000.0

   FINAL SLOPE (dB/OCT) : -3         OR     LAST LEVEL (GSQR/Hz) :

       TEST DATA PSD                          ANALYZE DATA PSD
 2) SELECT NEW DATA (Y,N):..)           3) SELECT NEW DATA (Y,N):..)
 TEST SET-UP ID :.........)             ANALYSIS SIGNAL NAME :..)
 TEST RUN NAME :..........)
 TEST PARAMETER :.........)             TEST PARAMETER :.........)
     (C=CONTROL,A=ANALYSIS)
 ALARM (+dB) :............)             ALARM (+dB) :............)
 ALARM (-dB) :............)             ALARM (-dB) :............)
 ABORT (+dB) :............)             ABORT (+dB) :............)
 ABORT (-dB) :............)             ABORT (-dB) :............)

CONTROL KEYS Esc Enter    End    PgDn    PgUp    (-        -)        ?-Help
```

Neglect TEST DATA PSD and ANALYZED DATA PSD for now.
Press (Shift, ?) to display HELP (pg.4) below:

```
                  TEST SETUP LINE ITEM DESCRIPTIONS ( pg 4 )

 REFERENCE PSD DEFINITION - Choose one of the following sources for
     defining the Reference PSD:
     (1) a Reference PSD Table to be specified in the following responses
     (2) Previously saved Test Data.
     (3) Previously saved Analyzed Data.

 LOWEST REFERENCE PSD FREQUENCY - Enter the lowest frequency (Hz) specified
     in the Reference PSD.

 INITIAL SLOPE - Enter the initial slope (dB/Oct) between the lowest
     frequency and the next higher breakpoint frequency at which the
     numerical value of the Reference PSD is given.

                                   OR

 FIRST LEVEL - Enter the value of the Reference PSD (g2/Hz) associated with
     the lowest frequency if the slope is not specified.


        PgDn - to continue      Esc - back to menu
```

Press (PgDn) to display HELP (pg.5) shown on p.3-17.

Note particularly the automatic calculation of PSD values when initial and final slopes are specified.

TEST SETUP LINE ITEM DESCRIPTIONS (pg 5)

HIGHEST REFERENCE PSD FREQUENCY - Enter the highest frequency specified in the Reference PSD.

FINAL SLOPE - Enter the slope (dB/Oct) between the last frequency in the profile at which the value for the Reference PSD is specified and the highest frequency.

OR

LAST LEVEL - Enter the value for the Reference PSD (g2/Hz) at the highest frequency if this is given when the slope is not specified. The values for the Reference PSD at the highest and lowest frequencies above will be automatically displayed when the level entries at the second and next to last frequencies are made.

TEST SETUP CONTROL KEYS on next page

PgUp - back up one screen PgDn - forward one screen Esc - back to menu

Press (PgDn) for a repetition of CONTROL KEY action.

TEST SETUP CONTROL KEYS (pg 6)

Esc - Exits the setup without recording changes. A "Y" answer to the subsequent prompt verifies that this is the true intent of the operation. A "N" answer cancels the Esc command.

Enter - Moves the cursor to the next entry in the setup list and displays the next page of the list if necessary.

End - Saves all setup entries on the hard disk and then returns to the Test Setup Menu

PgDn/PgUp - Moves to the next/previous page of the setup.

↑ ↓ - Moves the cursor to the entry above/below it.

<- - Moves the cursor one character to the left. If the cursor is on the first position of an entry it is moved to the first position of the entry to the left.

-> - Moves the cursor one character to the right.

PgUp - back up one screen Esc - back to menu

Press (Esc), then (PgDn) to display the REFERENCE PSD table on p.3-18.

Practice moving the cursor with the CONTROL KEYS, and editing the entries in the table below. Illegal entries will generally be acknowledged with a flashing error message. Press (F3).

REFERENCE PSD (0 dB)

Accel(g)Rms=8.01 Vel(in/sec)Rms=2.74 Disp(in)Rms=0.01

BRKPT NO.	FREQ (Hz)	LEVEL (GSQR/Hz)	ALARM (+dB)	ALARM (-dB)	ABORT (+dB)	ABORT (-dB)
1	20.00	.01750	3.0	3.0	6.0	6.0
2	80.00	.07000	3.0	3.0	6.0	6.0
3	350.00	.07000	3.0	3.0	6.0	6.0
4	2000.0	.01225	3.0	3.0	6.0	6.0

LO FREQ= 20.00Hz | HIGH FREQ=2000.00Hz | FREQ RES= 5.00Hz | EST PP DISP=0.1

CONTROL KEYS Esc Enter End PgDn PgUp (- -) Ins Del F2(R) F3(G) F4(D) ?-Help

Errors not acknowledged immediately will be displayed if an attempt is made to return to the R.V. TEST SETUP Menu via (Esc) or (End). Prrss (Shift, ?) to display HELP (pg.7) below.

REFERENCE PSD TABLE ENTRIES (pg 7)

FREQUENCY - The breakpoint frequencies used in the reference PSD.

LEVEL - Enter the PSD in g2/Hz associated with each of the breakpoint frequencies. it is assumed that straight lines connect the (FREQ.,LEVEL) entries on log-log coordinates.

ALARM - Enter the high alarm limit (+dB) and low alarm limit (-dB). These are defined relative to the reference PSD and apply to all spectral lines falling between the corresponding breakpoint and the next higher breakpoint.

ABORT - Enter the high abort limit (+dB) and low abort limit (-dB). These are defined similarly to these for the alarm limits. Both ALARM and ABORT limits are generally shown on the Control PSD graph.

NEW CONTROL KEYS

PgDn - to continue Esc - back to menu

Press (PgDn) for HELP (pg.8) shown on p. 3-19.

Carefully note the flexibility offered by the new CONTROL KEYS which are applicable only to the REFERENCE PSD TABLE:

TEST SETUP CONTROL KEYS (pg 8)

Ins - Allows new breakpoint entries at the cursor location without destroying existing breakpoint entries.

Del - Deletes breakpoint entry at the cursor location, and leaves remaining entries in order.

F2 - (R) - Rescales all Reference PSD table values by the specified change in dB.

F3 - (G) - Displays rms acceleration, rms velocity and rms displacement

F4 - (D) - Displays the graph of the Reference PSD

TEST SETUP CONTROL KEYS on next page

PgUp - back up one screen PgDn - forward one screen Esc - back to menu

Press (PgDn) for a description of the standard CONTROL ACTION:

TEST SETUP CONTROL KEYS (pg 9)

Esc - Exits the setup without recording changes. A "Y" answer to the subsequent prompt verifies that this is the true intent of the operation. A "N" answer cancels the Esc command.

Enter - Moves the cursor to the next entry in the setup list and displays the next page of the list if necessary.

End - Saves all setup entries on the hard disk and then returns to the Test Setup Menu

PgDn/PgUp - Moves to the next/previous page of the setup.

↑↓ - Moves the cursor to the entry above/below it.

<- - Moves the cursor one character to the left. If the cursor is on the first position of an entry it is moved to the first position of the entry to the left.

-> - Moves the cursor one character to the right.

PgUp - back up one screen Esc - back to menu

Press (Esc), then (PgDn) to proceed to the next page of TEST SETUP LINE ITEMS found on p.3-20.

```
DEGREES OF FREEDOM, DOF (25 to 400) : .........)100
     ± 1.0 db ACCURACY WITH 90% CONFIDENCE
     DISCOUNT FACTORS, Ky = Kx = 22
FRAMES/LOOP, L (4 to 43) : ....................)8

VARIABLE (V) OR FIXED (F) BANDWIDTH CHECKING :.)F
     (5Hz BW FIXED)

NUMBER OF LINES TO TRIGGER ALARM : ............)50
NUMBER OF LINES TO TRIGGER ABORT : ............)10

GRMS ABORT LIMIT (+dB) : 3.0              (-dB) : 3.0

N-SIGMA DRIVE LIMITING (N=NONE,2 to 4) : ......)3.0

ANALYSIS CHAN SCALING (re CONTROL)(.1 to 1) :..)0.3

AUTO RAMPING (1=SLOW,2=MED,3=FAST) : ..........)3

MULTIPLE LEVEL TEST (Y,N) : ...................)N
    LEVEL (-dB wrt REF) : 12.0
    DURATION : 0    HRS     0  MIN    15 SEC

CONTROL KEYS Esc Enter     End     PgUp     (-          -)          ?-Help
```

Press (Shift, ?) to display HELP (pg.10) below:

TEST SETUP LINE ITEM DESCRIPTIONS (pg 10)

DEGREES OF FREEDOM - Enter the value for the statistical degrees of freedom which determines control accuracy or confidence interval. The discount coefficients for averaging, Ky, and Kx are calculated and displayed.

FRAMES/LOOP - Enter the number of input frames of data processed for each new correction made to the output drive signal.

NUMBER OF LINES TO TRIGGER ALARM - Enter the number of spectral lines exceeding the alarm tolerances which are necessary to trigger an alarm signal.

NUMBER OF LINES TO TRIGGER ABORT - Enter the number of spectral lines exceeding the abort tolerances which are necessary to automatically cause the test to abort.

PgDn - to continue Esc - back to menu

Press (PgDn) to display HELP (pg.11) shown on p. 3-21.

TEST SETUP LINE ITEM DESCRIPTIONS (pg 11)

VARIABLE OR FIXED BANDWIDTH CHECKING - Provide variable bandwidth checking (V) if less resolution is desired at higher frequencies for the Control PSD. At the higher frequencies several adjacent spectral lines are averaged, displayed and then checked for alarm and abort conditions. Bandwidths are displayed.

GRMS ABORT - Enter the upper abort limit (+dB) and lower abort limit (-dB) relative to the rms value for the Reference PSD.

N-SIGMA DRIVE LIMITING - A numerical entry between 2 and 4 limits the drive voltage to peaks not exceeding the numerical entry times the rms value of the drive voltage.

AUTO RAMPING - Enter 1-Slow (0.5dB/sec), 2-medium (1.0dB/sec) or 3-fast (2dB/sec) to specify the rate at which drive level increases when the test enters the AUTO mode from the CALIBRATION, MANUAL or STANDBY modes.

PgUp - back up one screen PgDn - forward one screen Esc - back to menu

Press (PgDn) to display HELP (pg.12):

TEST SETUP LINE ITEM DESCRIPTIONS (pg 12)

ANALYSIS CHANNEL SCALING - Enter a value less than unity if it is expected that the rms value of the acceleration for the analysis channel is significantly greater than that for the control channel. This prevents signal clipping in the processor and the production of spurious spectral components.

MULTIPLE LEVEL TEST - Entry "N" indicates a single level test. The level (dB relative to the Reference PSD) and duration are then requested. Entry "Y" causes the level schedule to be displayed for specification of a multiple level test.

LEVEL - Entry gives level in dB less than the reference PSD (0. to 20.0)

DURATION - Three entries give the test duration in hr:min:sec for the associated LEVEL entry, when "N" is entered above.

PgUp - back up one screen PgDn - forward one screen Esc - back to menu

Press (Esc) and bypass HELP (pg.13). Edit the response to MULTIPLE LEVEL TEST to (Y) if necessary, and press (PgDn) to obtain the LEVEL SCHEDULE on p.3-22.

The LEVEL SCHEDULE below will be performed automatically after the test starts when the system remains in the AUTO mode. Note the display of total test time.

LEVEL SCHEDULE

LEVEL STEP NO.	LEVEL (-dB REL TO REF)	DURATION (HR :MIN:SEC)	PERFORM STEPS FROM	TO	TIMES
1	12.0	15			
2	6.0	30			
3	.0	1 5 10	1	2	2

total time 1 hours 6 min 40 sec

CONTROL KEYS Esc Enter End PgDn PgUp (- -) Ins Del ?-Help

Press (Shift, ?) to display HELP (pg.14) shown below:

TEST LEVEL TABLE ENTRIES (pg 14)

LEVEL - Entry gives level in dB less than the reference PSD (0. to 20.0)

DURATION - Three entries give the test duration in hr:min:sec for the associated LEVEL entry.

PERFORM STEPS - Enter beginning step in FROM column, ending step in TO column and the total no. of times in TIMES column. Error messages enforce the necessary loop nesting requirements. The statements do not have to be on same line as the beginning step number.

NEW CONTROL KEYS

Ins Del

PgDn - to continue Esc - back to menu

Press (PgDn) to display HELP (pg.15) shown on p.3-23.

Note that (Ins) and (Del) have similar actions to those for the REFERENCE PSD TABLE.

TEST SETUP CONTROL KEYS (pg 15)

Ins - Allows new test level entries at the cursor location without destroying existing level entries.

Del - Deletes level entry at the cursor location, and leaves remaining entries in order.

TEST SETUP CONTROL KEYS on next page

PgUp - back up one screen PgDn - forward one screen Esc - back to menu

Press (PgDn) to display HELP (pg.16). This is a repetition of the standard CONTROL KEY description.

TEST SETUP CONTROL KEYS (pg 16)

Esc - Exits the setup without recording changes. A "Y" answer to the subsequent prompt verifies that this is the true intent of the operation. A "N" answer cancels the Esc command.

Enter - Moves the cursor to the next entry in the setup list and displays the next page of the list if necessary.

End - Saves all setup entries on the hard disk and then returns to the Test Setup Menu

PgDn/PgUp - Moves to the next/previous page of the setup.

↑↓ - Moves the cursor to the entry above/below it.

(- - Moves the cursor one character to the left. If the cursor is on the first position of an entry it is moved to the first position of the entry to the left.

-) - Moves the cursor one character to the right.

PgUp - back up one screen Esc - back to menu

Press (Esc) to return to the LEVEL SCHEDULE TABLE.
Press (Esc) again, and answer (Y) to the question about not saving changes. This returns you to the R.V. TEST SETUP Menu on p.3-6.
Continue on p.3-24.

Press (F10) to exit to the R.V. TEST Menu on p.3-4.

Press (F1) to display the R.V. TEST SEQUENCE Menu shown immediately below.

Then press (F1) again to begin the CREATE/EDIT process.

The last saved TEST SEQUENCE ID is the default entry shown on the screen.

```
                    RANDOM VIBRATION TEST SEQUENCE

F1 = CREATE/EDIT                    F2 = RENAME

F3 = DISPLAY                        F4 = DISPLAY TEST SEQUENCE LIST

F5 = PRINT                          F6 = PRINT TEST SEQUENCE LIST

F7 = RUN TEST SEQUENCE              F8 = DELETE

F9 = COPY                           F10 = EXIT TO PREVIOUS MENU
```

```
 TEST SEQUENCE ID : DAVSEQ
SPACE AVAILABLE FOR 13316 SEQUENCES
     Esc (Back to Menu)       Enter (Accepts Entry)
```

We have a choice of three courses of action:
1- To create a new test sequence, type a new ID.
2- To examine and possibly edit another save test sequence, type the corresponding ID. Earlier action with (F4) or (F6) would provide necessary information.
3- To examine and possibly the test sequence above, do not change the entry.

We will follow the third choice.

Press (Enter), and the sequence description appears on p.3-25.

RANDOM TEST SEQUENCE

SEQUENCE ID :.....)DAVSEQ Last Changed : 04/22/86 10:01:40

SEQUENCE DESCRIPTION :.)
This was entered for demonstration purposes only.

CONTROL KEYS Esc Enter End PgDn (- -) ?-Help

Press (Shift, ?) to display the HELP page below:

RANDOM TEST SEQUENCE ENTRIES

SEQUENCE DESCRIPTION - Enter a one line (60 character maximum) description of the test sequence.

Esc - back to menu

Press (Esc) and (PgDn) to display the TEST SEQUENCE TABLE on p.3-26.

TEST SEQUENCE TABLE

SETUP NO.	SETUP ID	PERFORM SETUPS FROM	TO	TIMES
1	DEMOTEST			
2	ACRTEST			
3	DEMOTEST			
4	ACRTEST	1	3	2

CONTROL KEYS Esc Enter End PgUp (- -) Ins Del ?-Help

Press (Shift, ?) to display the HELP page below:

TEST SEQUENCE TABLE

SETUP ID - Enter the test setup ID's in the order that the tests are desired to be run.

PERFORM SETUPS - For repeated test setup subsequences within the sequence list enter the beginning setup number in the FROM column and the ending setup number in the TO column. The entry in the TIMES column gives the number of times this subsequence is repeated. Error statements reinforce necessary loop nesting requirements for loops within loops. The statements do not have to be on the same line as the beginning step number.

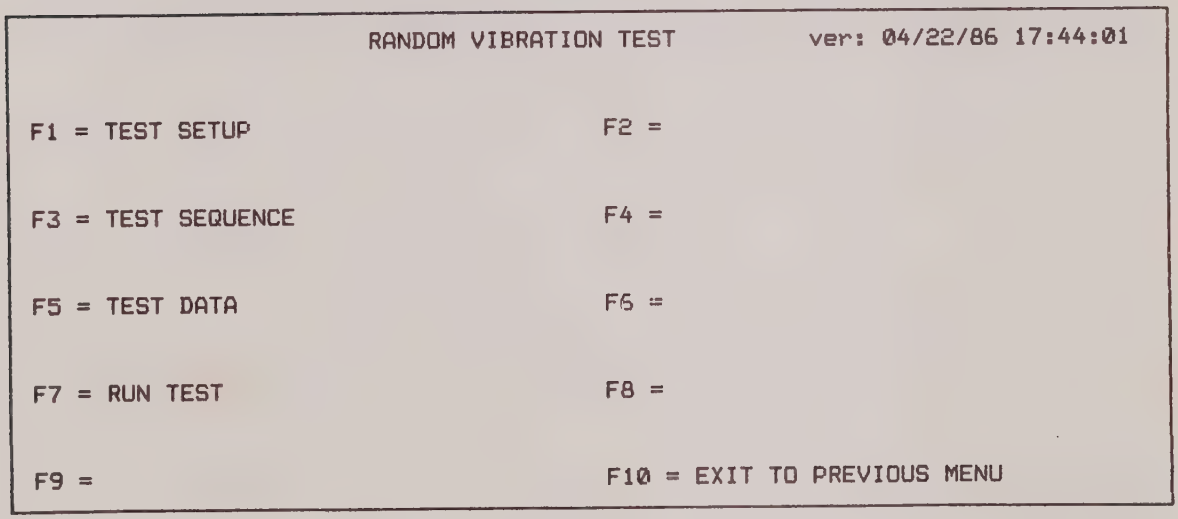
Ins - Allows new test setup entry at the cursor location without destroying existing setup entries.

Del - Deletes the setup entry at the cursor location and leaves the remaining setup entries in order.

Esc - back to menu

Press (Esc) to the table above. Then press (Esc) and then (Y) to return to the R.V. TEST SEQUENCE Menu. Press (F10) to return to the R.V. TEST Menu on p.3-4, also repeated on p.3-27. Continue.

At this point we have investigated the courses of action possible by selecting either (F1), (F3), (F5) or (F7) from the Menu below. You may desire to run a complete test, a test sequence, or investigate specific test data. These operations are described in following chapters.



THIS MARKS THE END OF THE PRELIMINARY GUIDED TOUR OF THE U-D 400AT. Operations necessary for running a complete test are explained in Chapter 4.

3.5 New Features and Additions

Several line items and entries have been added to the RANDOM TEST SETUP shown on pages 3-14, 3-16, 3-18, 3-20 and 3-22.

A selectable input sensitivity of 10, 100 or 1000 mV/g has been provided for those users running very low level tests. The default entry is 10 mV/g.

The vibration level during the initial calibration sequence was -20 dB relative to full test level. A line item has been added so that a value from -20 to -6 dB may be entered to help those users with low test levels for which -20 dB would be below system noise components. The default entry is -20 dB.

Level entries for the LEVEL SCHEDULE table as shown on p. 3-22 had previously been limited to a range from -20 dB to 0 dB. A zero level (no vibration) may also be obtained with an entry of (N). This is especially useful for a coordinated environmental test including temperature and humidity control where portions of the test require no vibration.

HELP pages have been revised where necessary.

4. PERFORMING THE RANDOM VIBRATION TEST

4.1 Introduction

In Chapter 3 we took a detailed tour through the various menus and test description procedures. We did, however, stop short of actually initiating a random vibration test (See pp. 3-11 through 3-13). Now we are ready to take the steps necessary for performing and completing a test run. These steps, as well as data display techniques and operational procedures that are possible during the performance of the test, are explained in the following sections.

4.2 Initial Procedure

As outlined in Section 3.2, make sure that all installation procedures described in Chapter 2 have been completed successfully. Also check that the remainder of the procedures in Section 3.2 has been followed. The power amplifier should be turned on so that it is ready to apply a signal to the shaker. See the manufacturer's instructions if necessary. The amplifier gain control should be adjusted for maximum gain.

Again, when the U-D 400AT System Logo appears on the color monitor, we are almost ready to start the test.

If it is desired to check the 400AT without exciting the power amplifier and shaker, this can be done by connecting an attenuator (gain $\simeq 0.2$) between the DRIVE output and the CHANNEL 1 (10mV/g) input of the UD 320. The TEST SETUP entry for control channel sequence should show the single input channel.

4.3 Test Setup

As an aid to our understanding of the procedures in this chapter, and the parameters found on the graphical displays, we will obtain a copy of the RANDOM VIBRATION TEST SETUP that pertains to our TEST RUNS.

Press any key to display the MAJOR OPERATIONAL MODES Menu.
Press (F1) to display the R.V. TEST Menu.
Press (F1) to display the R.V. TEST SETUP Menu.
Press (F5) to print the R.V. TEST SETUP used in the remainder of this chapter.

In response to PRINT TEST SETUP-ID: we typed (DEMOTEST), (Enter). In response to REF PSD GRAPH <Y,N>, we confirmed (N). A copy of the printout for the RANDOM TEST SETUP parameters only is shown on the next page.

The results described in the remainder of this chapter were actually taken on a U-D Model 560 Shaker with a resonant beam. The three control accelerometers were placed so that the acceleration PSD's differed considerably in the upper portion of the frequency range. In this fashion, the capability of the 400AT for both average and extremal control will be demonstrated.

RANDOM VIBRATION TEST SETUP

current date : 05/05/86
: 14:06:09
last updated : 05/05/86
: 14:05:59

TEST SETUP ID :.....)DEMOTEST

TEST DESCRIPTION : UD560 SHAKER WITH 160LB MASS AND RESONANT BEAM LOAD.

ARMATURE WEIGHT (LB) : .....)45.0

LOAD WEIGHT (LB) : .....)160.0

CONTROL CHANNEL INPUT SEQUENCE : .....)1,2,3,
(1=CH1,2=CH2,3=CH3,4=CH4,5=CH5,6=CH6,7=CH7,8=CH8)

MULTIPLE CHANNEL CONTROL STRATEGY : .....)1
(1=AVG,2=EXTREMAL)

MAXIMUM ANALYSIS FREQUENCY : .....)4
(1=250Hz,2=625Hz,3=1250Hz,4=2500Hz)

LINES/FREQUENCY RESOLUTION : .....)3
(1=125/20Hz,2=250/10Hz,3=500/5Hz)

DEGREES OF FREEDOM, DOF (25 to 400) : .....)100
+/- 1.0 dB ACCURACY WITH 90% CONFIDENCE
DISCOUNT FACTORS, Ky = Kx = 22

FRAMES/LOOP, L (4 to 43) : .....)8

VARIABLE (V) OR FIXED (F) BANDWIDTH CHECKING :)F
(5.00Hz BW FIXED)

NUMBER OF LINES TO TRIGGER ALARM : .....)50

NUMBER OF LINES TO TRIGGER ABORT : .....)10

GRMS ABORT LIMIT (+dB) : 3.0 (-dB) : 3.0

N-SIGMA DRIVE LIMITING (N=NONE,2to4) : .....)3.0

ANALYSIS CHAN SCALING (re CONTROL) (.1 to 1) :. 0.3

AUTO RAMPING (1=SLOW,2=MED,3=FAST) : .....)3

MULTIPLE LEVEL TEST (Y,N) : .....)Y

REFERENCE PSD (0 dB)

INITIAL SLOPE (dB/OCT) : 3

FINAL SLOPE (dB/OCT) : -3

ACCEL(g)Rms=8.01 VEL(in/sec)Rms=2.74 DISP(in)Rms=0.01

BRKPT NO.	FREQ (Hz)	LEVEL (GSQR/Hz)	ALARM (+dB)	ALARM (-dB)	ABORT (+dB)	ABORT (-dB)
1	20.00	0.01750	3.0	3.0	6.0	6.0
2	80.00	0.07000	3.0	3.0	6.0	6.0
3	350.00	0.07000	3.0	3.0	6.0	6.0
4	2000.00	0.01225	3.0	3.0	6.0	6.0

LO FREQ= 20.00Hz | HIGH FREQ=2000.00Hz | FREQ RES= 5.00Hz | EST PP DISP= 0.1 in

LEVEL SCHEDULE

LEVEL STEP NO.	LEVEL (-dB REL TO REF)	DURATION (HR :MIN:SEC)	PERFORM STEPS FROM	TO	TIMES
1	12.0	15			
2	6.0	30			
3	0.0	1 5 10	1	2	2

total time = 1 hrs 6 min 40 sec

4.4 Beginning the Test Run

After the printout of the RANDOM TEST SETUP begins, the queries disappear on the screen, and the R.V. TEST SETUP Menu remains.

Press (F7-RUN TEST) and three queries appear below the menu.

Enter (DEMOTEST) for the TEST SETUP-ID.
Confirm (3) for no automatic data saves.
Confirm (default entry) for the TEST RUN NAME.
(The TEST RUN name is automatically changed after each test run, say from RUN 96 to RUN 97).

In a few seconds, a graph with notations around the border is displayed. The notations are those shown on graphs found later in this chapter. At the bottom is a two row display with space for describing the purpose for each of the ten FUNCTION KEYS. Only the active keys, however, have their function printed in the associated space, and the remainder of the spaces are blank.

Just above the function key display, the Status message is displayed:

Status: Use function keys to continue.

Three FUNCTION KEYS are active:
(F3-Auto); (F5-Manual); (F10 Leave Test).

A choice of (F10) causes the R.V. TEST SETUP Menu to be displayed again. A choice of either (F3) or (F5) causes the low level CALIBRATION sequence to begin. When the CALIBRATION sequence is complete, the test level is automatically established at the first level determined in the LEVEL SCHEDULE, if the AUTO mode (F3) was initially selected. The AUTO clock is then started and the remainder of the details in the LEVEL SCHEDULE are accomplished automatically if no further interruptions occur.

If the MANUAL mode (F5) is chosen to initiate the CALIBRATION sequence, then the test level will be established at -20 dB when the CALIBRATION sequence is complete. The test level will remain at this value until further control operations are made. The AUTO clock does not run in the MANUAL mode, but the TOTAL clock runs continuously during the test run.

We will choose the AUTO mode to initiate the CALIBRATION sequence:

Press (F3).

Immediately following, the Status changes to "Auto Ranging" and (F1-Abort) is the only active FUNCTION key. A low level (approximately -20 dB) random signal is applied to the shaker. Vertical (g^2/Hz) and horizontal (Hz) scaling appear, as well as the reference PSD, and continuously updated measurements of the Control PSD.

During this time the estimate for the transfer function of the shaker and test specimen is being improved, and auto ranging is

repeated so that maximum signal-to-noise ratio is obtained for both the input A/D converter and the output D/A converter in the UD320 HSDSP.

After a period of time (about 45 seconds for this particular set-up) the CALIBRATION sequence is complete and the Status changes to "Ramping". The vibration level is now increasing to the first level on the LEVEL SCHEDULE at a rate determined by the AUTO RAMPING line entry in the R.V. TEST SETUP (See p 4-2).

Very quickly the Status changes to "Auto". The graph grid lines, the Reference PSD, and the alarm and abort limits appear. The numerical entries appear below the graph for the REF GRMS, CON GRMS, AUTO time and TOTAL time. The display is nearly identical to the first one shown in the following section.

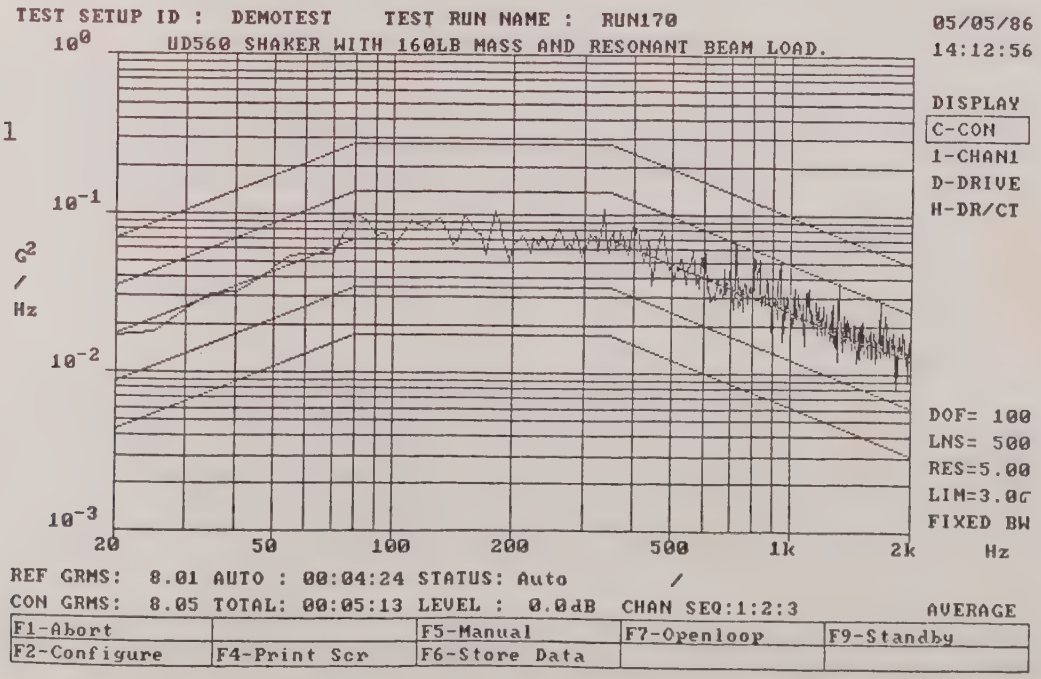
The test has begun.

4.5 During the Test Run - Average Control

The displays shown in the remainder of the chapter were obtained from printed copies obtained by pressing (F4-PrintScr) when a copy was desired. The (F4) command causes the graphical displays to be rotated 90° before appearing on the printer paper. This allows the graphical material to occupy a full sheet of the (8.5 x 11) printed copy. The copies shown in this manual are reduced to approximately 65% of full size to conserve space. Do not attempt to use the (Shift, PrtSc) command to print graphical material, because this causes a useless printer output.

The test run was allowed to cycle from LEVEL STEP NO. 1 to LEVEL STEP NO. 2, as prescribed in the LEVEL SCHEDULE. The display copy shown below was made after the test run entered LEVEL STEP NO. 3:

Fig. 4-1



Most of the relevant test information can be found on the display. On the top border, the TEST SETUP ID and TEST RUN NAME are given, as well as the TEST DESCRIPTION. In the upper right-hand corner is the DATE and TIME when the copy was made.

On the right border, the parameter being displayed is shown in a box under DISPLAY. Other choices are listed. Other parameters for the test on the right border are: DOF-Degrees of freedom; LNS-Max. no. of analysis lines; RES-Resolution or line separation in Hz; LIM-Sigma multiplier for drive limiting; FIXED BW or VAR BW checking.

Below the graph, several dynamic test variables are displayed. The REF GRMS is the rms acceleration theoretically calculated from the REFERENCE PSD (full test level = O dB). The CON GRMS is the rms control acceleration calculated from the displayed control PSD for the actual test level. The actual test level is specified by LEVEL in dB relative to the full test level.

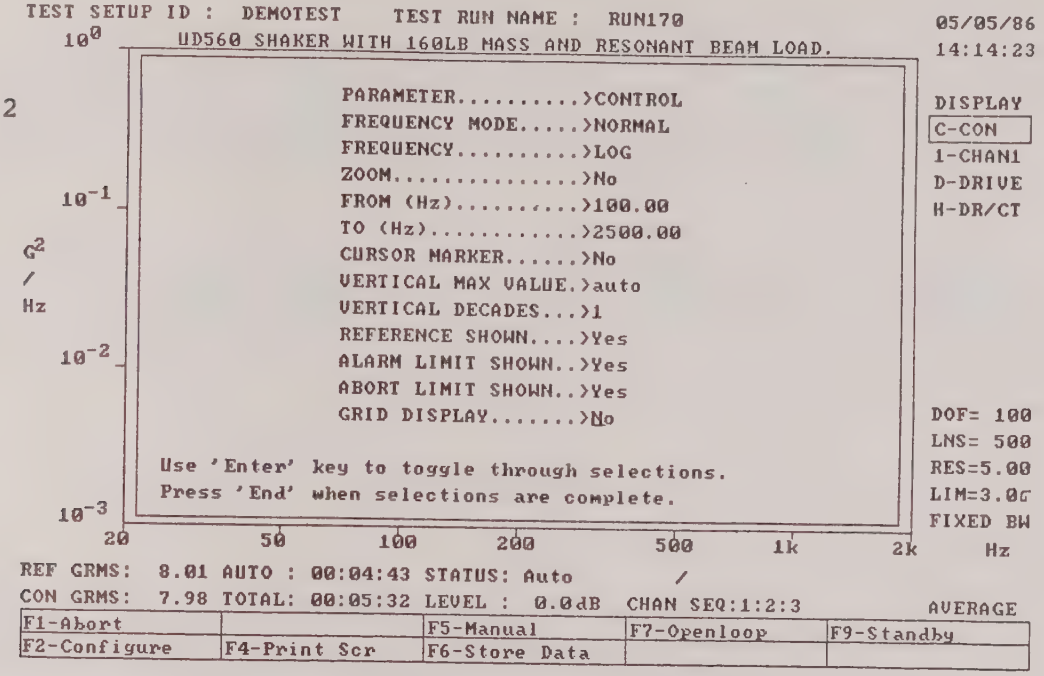
Note that CON GRMS varies slightly from display to display, but not nearly so much as individual spectral lines vary. The CON GRMS should be lower than the REF GRMS by very nearly the ratio indicated by the LEVEL value.

There are two clocks which relate to test duration. AUTO displays the time during the test spent in the AUTO mode only. TOTAL displays the total elapsed time since the calibration mode was initiated. This includes the time spent in the AUTO, MANUAL and OPEN LOOP modes, as well as in STANDBY and ABORT, when the ABORT command comes from (F1).

However, when the ABORT command originates internal to the UD320 as a result of the required number of spectral lines exceeding the abort limits or the rms control acceleration exceeding the abort limits, both AUTO and TOTAL clocks stop. The Status displays the appropriate reason for the ABORT. Normally, the TOTAL clock runs until the graph display is caused to disappear from the screen as a result of a (F7-Restart Test) or (F10 - Leave Test) command, or until the test run as defined in the LEVEL SCHEDULE is finished.

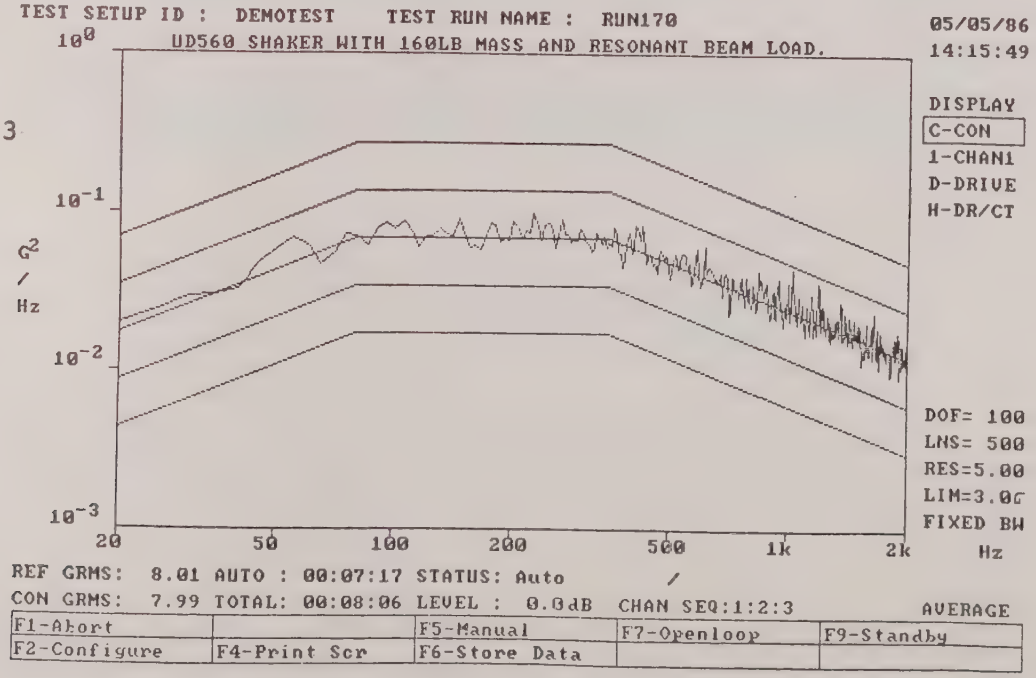
To change the configuration of the test graph, press (F2-Configure). The configuration parameters then scroll down the screen in place of the graph as shown below:

Fig. 4-2



Some operators prefer not to see the grid lines, as they may tend to obscure some data details. To remove the grid lines move the cursor to GRID DISPLAY and toggle to the "No" response with the (Enter) key. Then press (End). The Control acceleration PSD is displayed below:

Fig. 4-3



Also, near the bottom right-hand corner of the display, the CHAN SEQ: 1,2,3 and AVERAGE denotes that the control PSD is the average PSD of the three input channels. To view the acceleration PSD of each of the control channels, enter (1) for Channel 1, (2) for Channel 2 and (3) for Channel 3. The results are shown in the three following displays:

Fig. 4-4

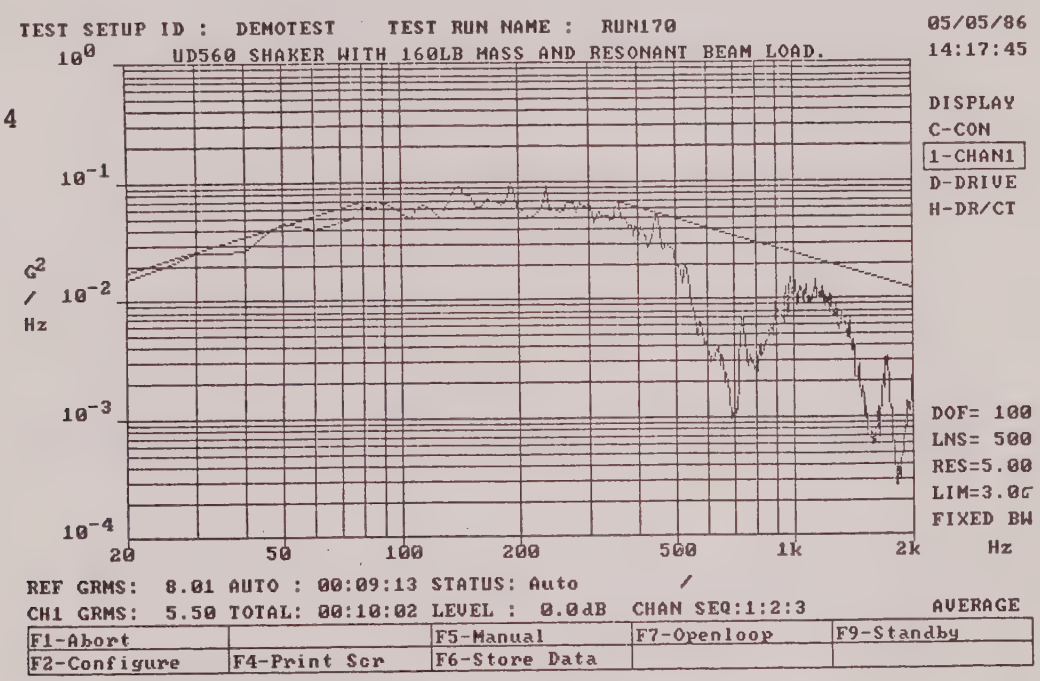


Fig. 4-5

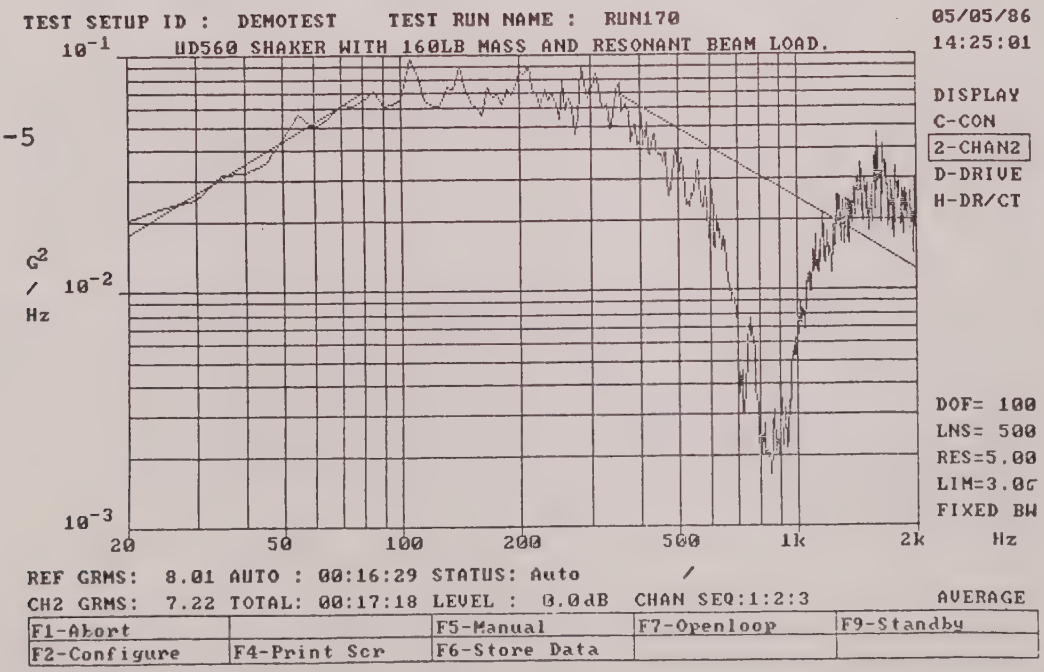
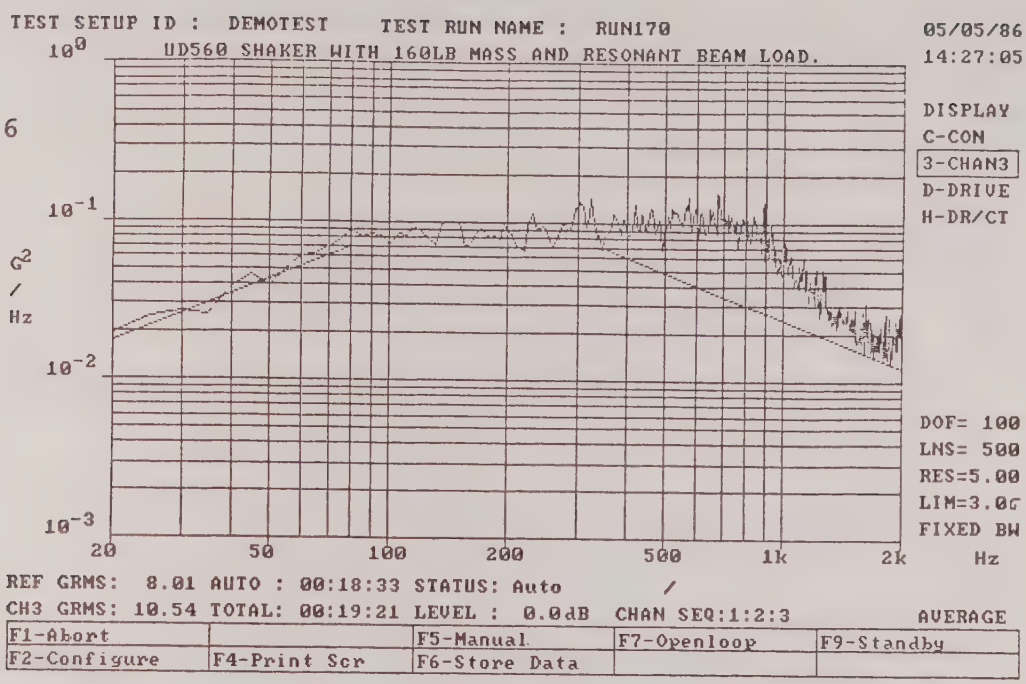


Fig. 4-6



The PSD data for the three channels above can be checked to show that the control PSD is the average of the three PSD's above at every frequency. For example, at 1250 Hz we have:

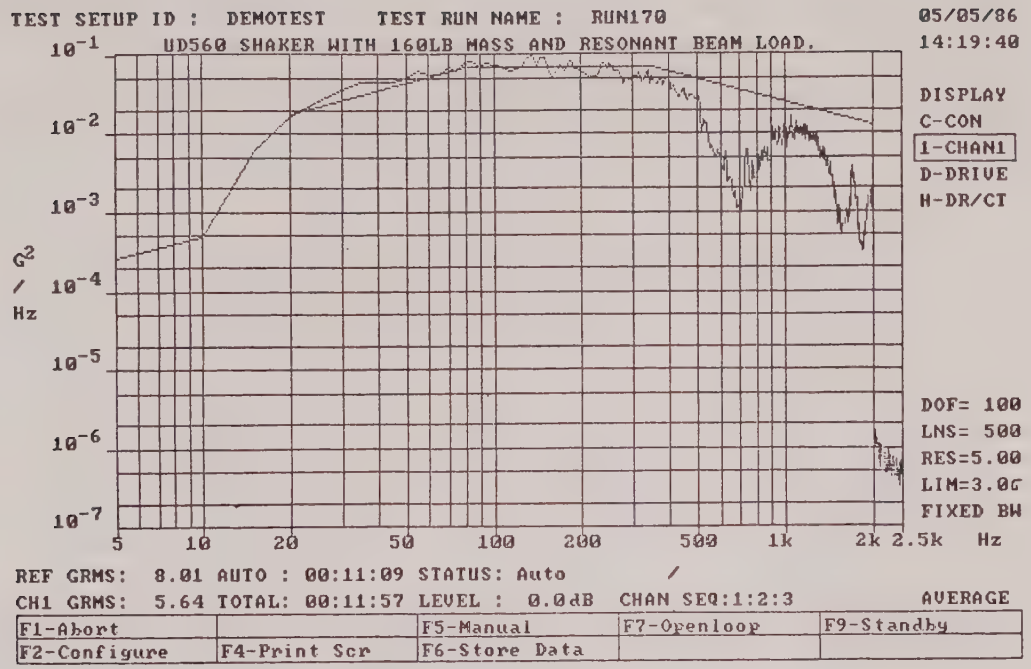
$$(S_{11} + S_{22} + S_{33})/3 = (10^{-2} + 2x10^{-2} + 3x10-^{2})/3 = 2x10^{-2}\ g^2/Hz$$

This checks very closely with the control PSD or Reference PSD at 1250 Hz.

Suppose further information about Channel 1 is desired. First of all, more information about energy outside the 20-2000 Hz test limits may be needed. Second, expanded detail in the 1000-2000 Hz region might be important. To accomplish the first objective, press (F2) to reconfigure the graph. Move the cursor to FREQUENCY MODE and toggle the entry to WIDEBAND. Press (End).The result follows on p. 4-9, and the frequency scale is widened to 5-2500 Hz.

For this display, it can be seen that the out-of-band PSD is about 40 dB lower than the control PSD above 2 kHz. Below 20 Hz, the PSD decreases, but not as much because of spectral smearing due to Hanning windowing. About 5-6 dB decrease per unit resolution/line separation can be expected. This effect can be seen at high frequencies also, but is not as clearly seen because individual lines are crowded much more closely together by the logarithmic frequency scale.

Fig. 4-7

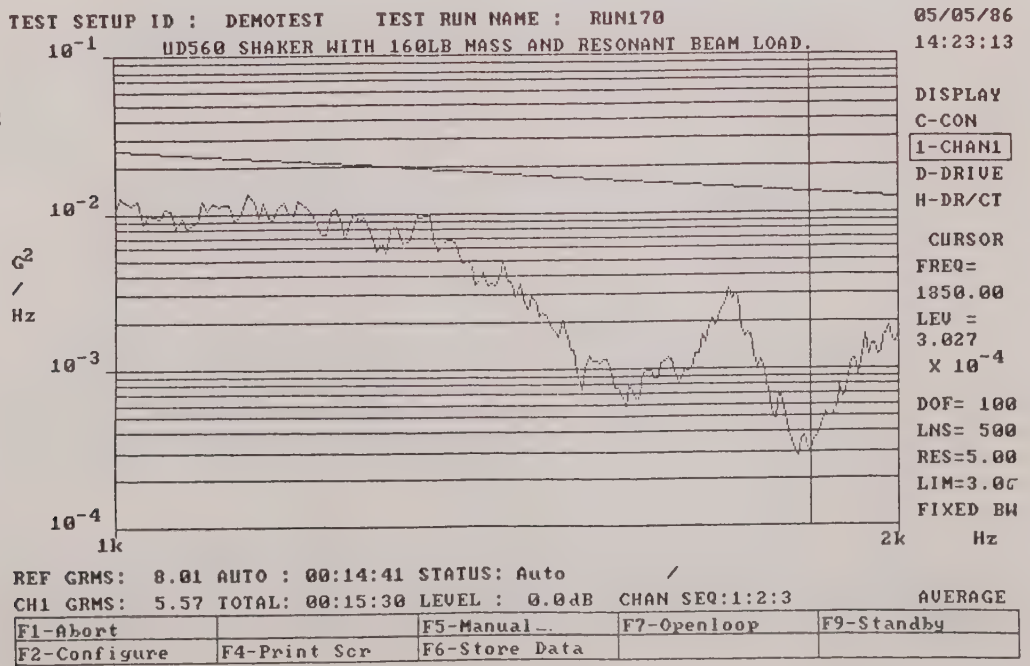


To accomplish the second goal of providing more detail in the 1-2 kHz region, press (F2)to reconfigure. Enter the following changes:

ZOOM.....> Yes
FROM (Hz).....> 1000.
TO (Hz).....> 2000.
CURSOR MARKER.....> Yes

Press (End). The result is shown on the following display:

Fig. 4-8



The vertical cursor can be moved back and both with the directional CONTROL KEYS. The readout of LEV in g^2/Hz and FREQ in (Hz) is given on the right-hand border of the display.

Finally, the displays for the drive voltage PSD and the system transfer function are obtained by typing (D) for the former and (H) for the latter. Both of these displays follow.

Fig. 4-9

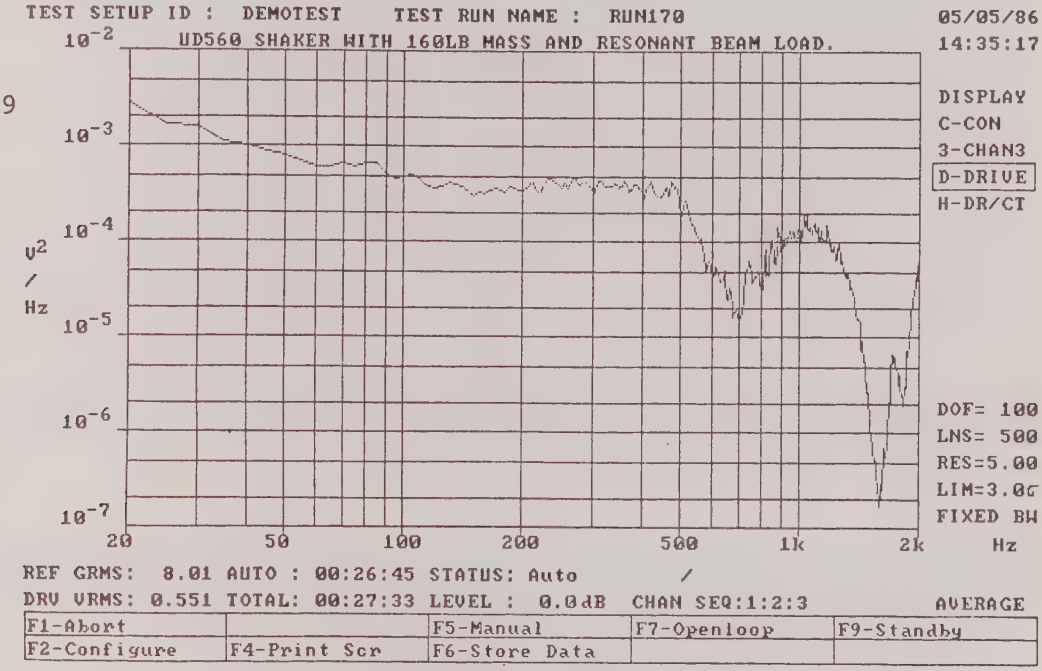
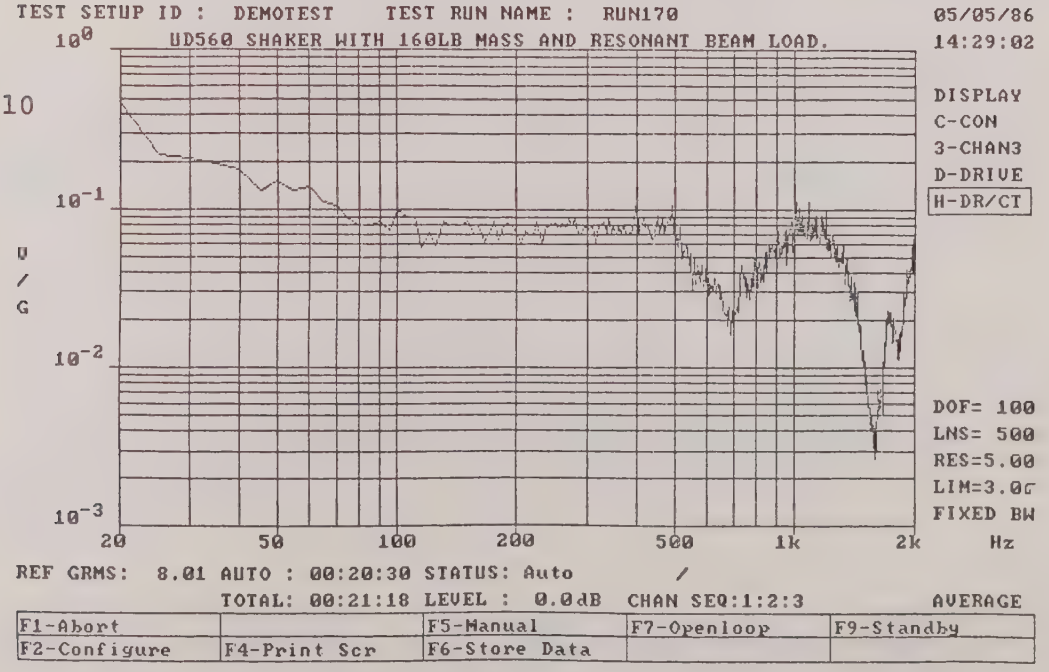


Fig. 4-10



Note that the rms drive voltage is displayed in the graph on p. 4-10 for Drive Voltage PSD.

To end the test run, we have two alternatives:

1 - To leave the system in the AUTO mode and allow the completion of the LEVEL SCHEDULE. The Status indicates "Finished". Press (F10).

2 - To press (F1) or (F9) and then press (F10).

4.6 Another Test Run - Extremal Control

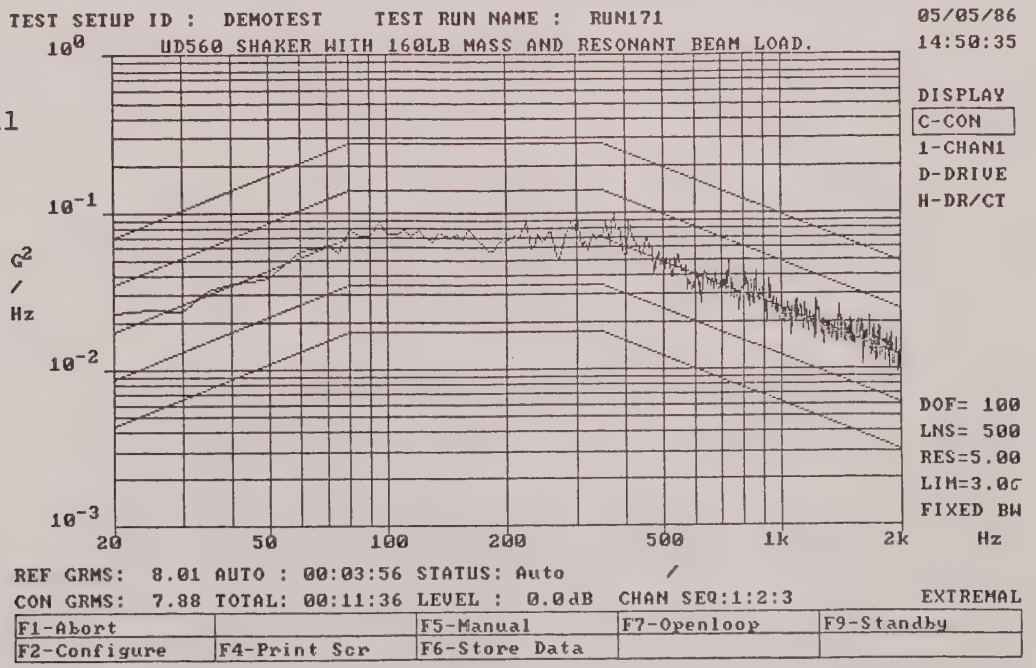
The following may be tried if the Extremal Control Option is supplied:

Summon CREATE/EDIT from the R.V. TEST SETUP Menu and change the line item for MULTIPLE CHANNEL CONTROL STRATEGY to 2 (Extremal) for the Test Setup just finished in Section 4.5. Press (End).

Repeat the procedure outlined in Section 4.4. Note that the CALIBRATION sequence takes about three times as long to accomplish because there are three inputs, the PSD's of which are calculated serially for purposes of comparison.

The display shown below was taken during LEVEL STEP NO. 3 of the LEVEL SCHEDULE. Note the acknowledgment of EXTREMAL control.

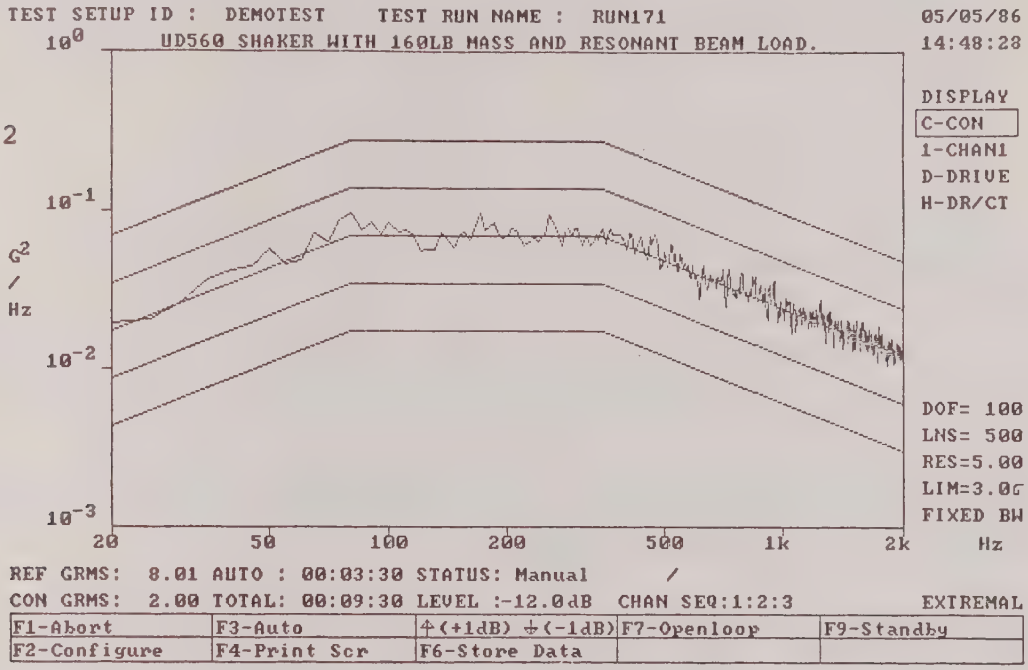
Fig. 4-11



Following a reconfiguration to remove the grid lines, (F5) was pressed to switch to the MANUAL mode. In the MANUAL mode, the UP and DOWN CONTROL keys become active to raise or lower the level by 1 dB each time one is pressed. Holding one key down continuously

causes a rapid level change. The LEVEL cannot exceed 0 dB or fall below -20 dB. Note that the action of the UP and DOWN CONTROL keys is displayed in place of the description for (F5) in the resulting display below:

Fig. 4-12



By pressing (F3) and returning to the AUTO mode, the following displays for the acceleration PSD for channels 1, 2 and 3 were obtained:

Fig. 4-13

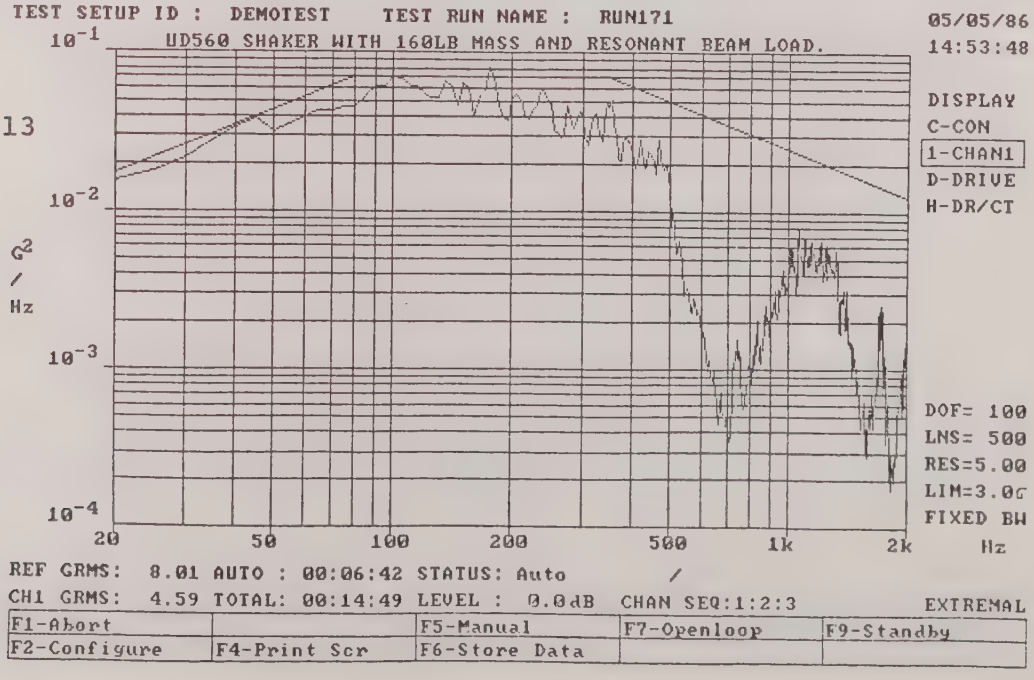


Fig. 4-14

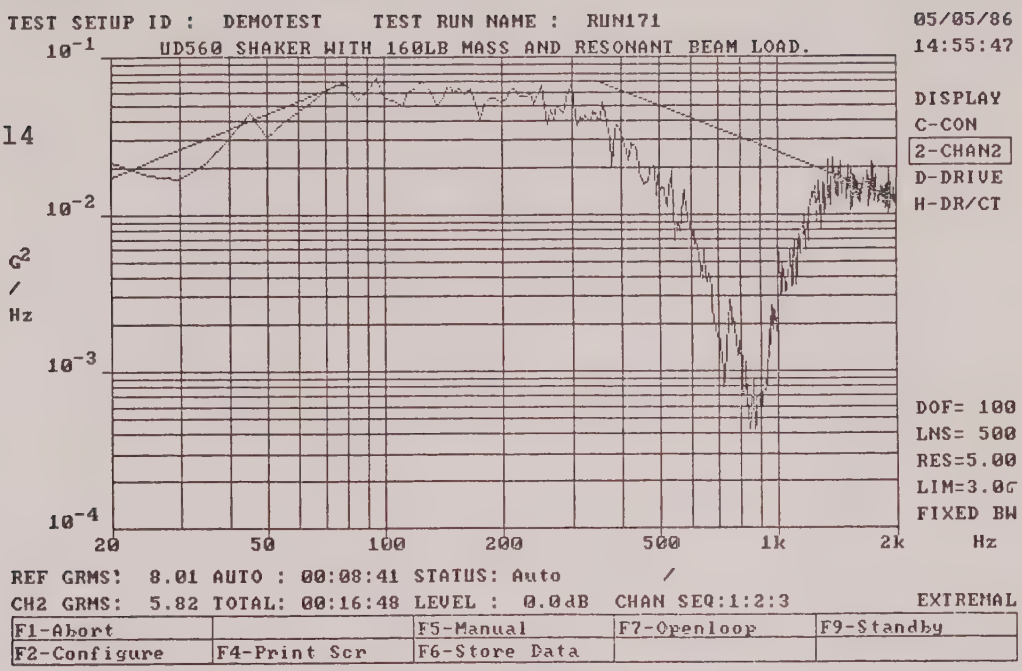
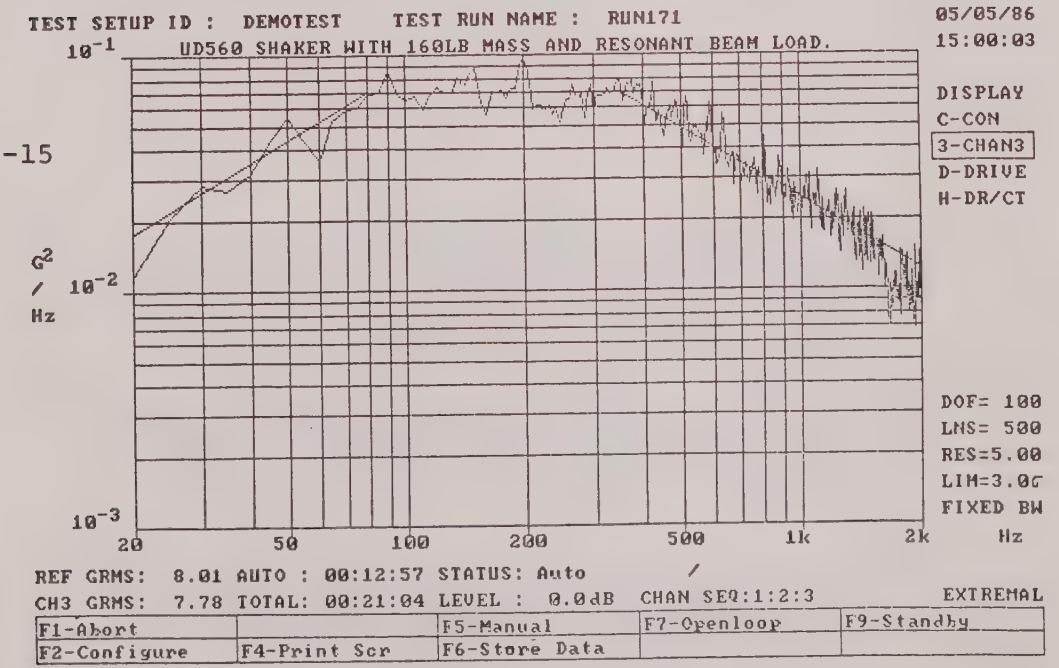


Fig. 4-15



An examination of the displays above shows that Channels 1, 2 and 3 share control, since all PSD's are approximately equal from 20 to perhaps 100 Hz. Above 100 Hz to approximately 1400 Hz, Channel 3 takes over control, and from 1400 to 2000 Hz, Channel 2 is in control. Note that except for statistical variations, the PSD's for all channels never exceed the Reference PSD for EXTREMAL control.

The graphs of the Drive Voltage PSD and the System Transfer Function are shown in the displays below to complete the description of the test.

Fig. 4-16

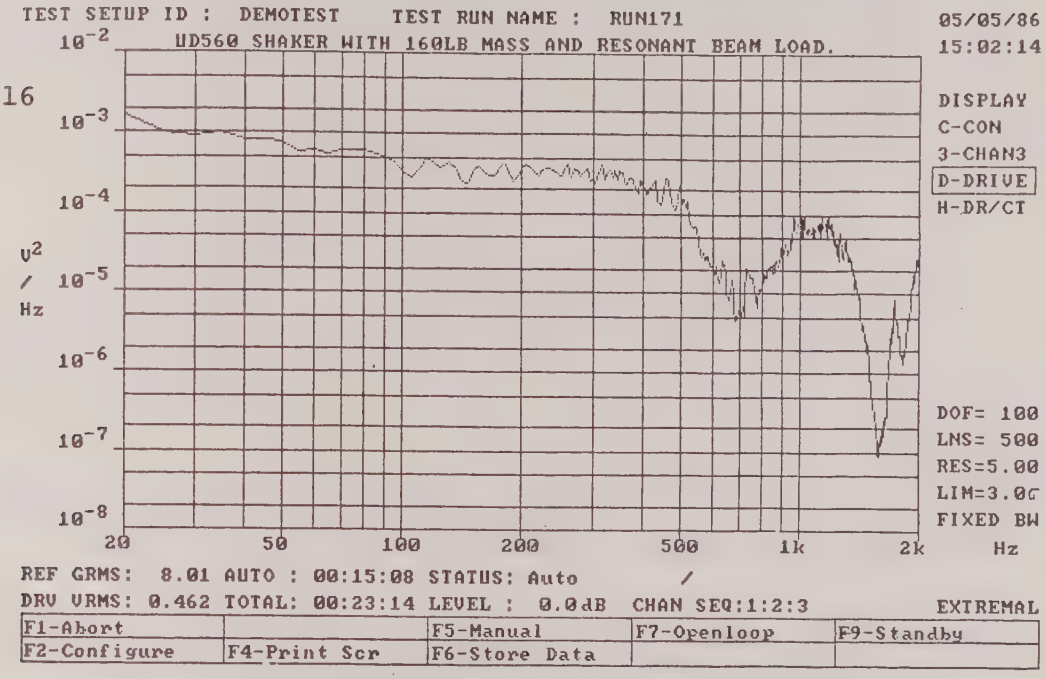
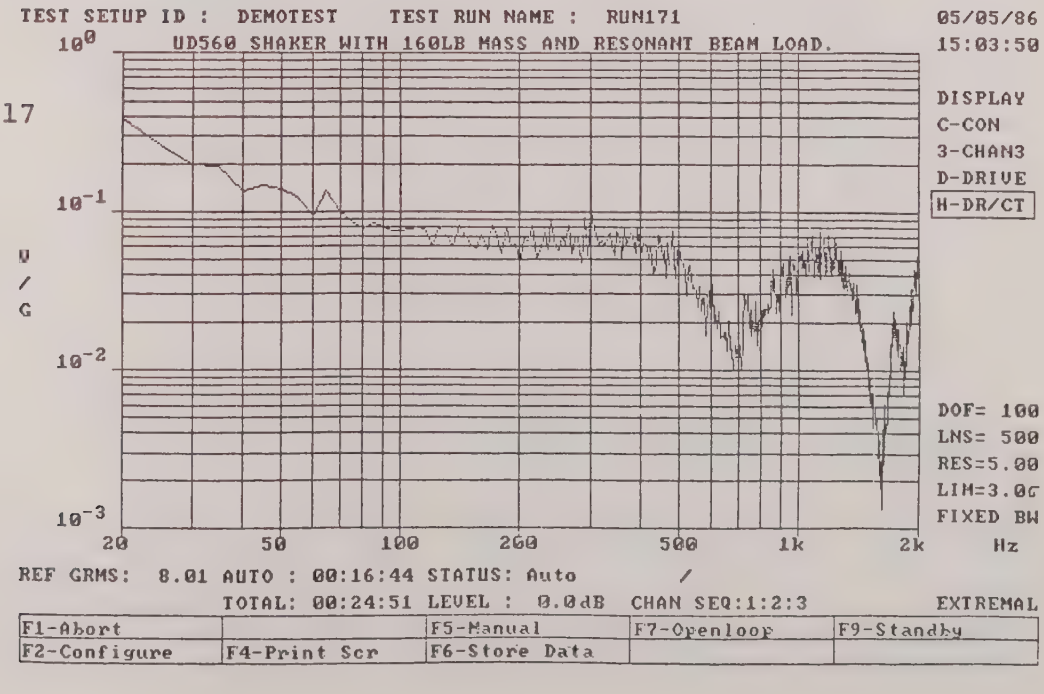


Fig. 4-17



4.7 Variable Bandwidth Checking

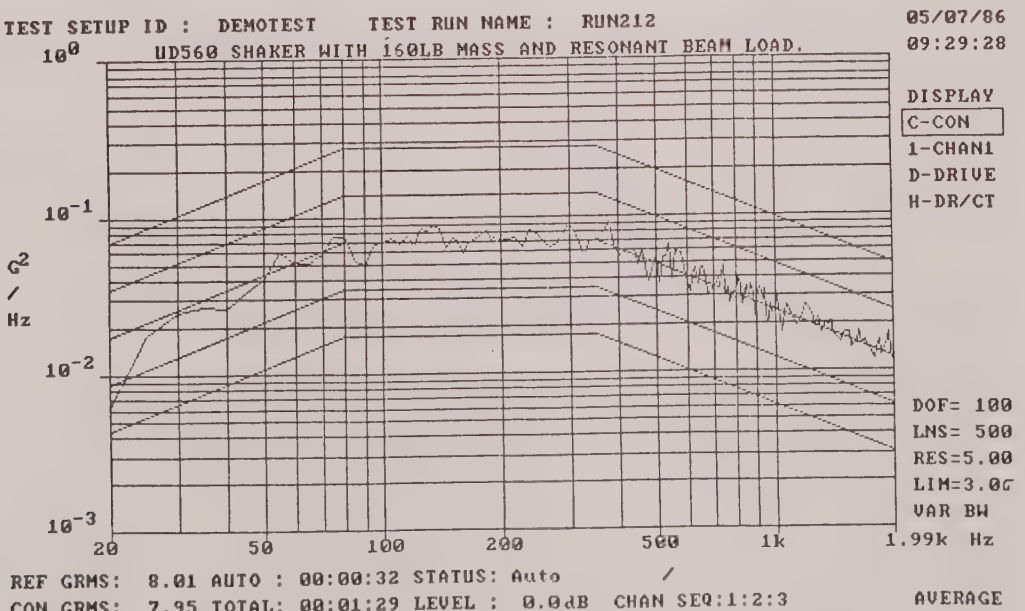
From the Control acceleration PSD graph for AVERAGE control (Fig. 4.2) it can be seen that the deviation of the Control PSD from the Reference PSD approaches 3 dB at the higher frequencies. The deviation is significantly larger than the 100 DOF would suggest. Upon inspecting the PSD's for Channels 1 through 3 (Figs. 4.4, 4.5, 4.6), it can be seen that above 300 Hz averaging is very active due to the large difference in all three PSD's.

In the frequency range from 700 to 1000 Hz particularly, Channels 1 and 2 have very low PSD's and Channel 3 is nearly three times the Reference value. Utilizing the reasoning in Section 1.4.5, the effective number of DOF approaches 100/3 or 33 in this frequency band. The corresponding confidence interval is $\pm$1.7 dB with 90% confidence. The larger confidence interval yields the larger deviations observed.

If less observable deviation is desired, and an increase of DOF due to an increase in averaging time (and response time) is not desirable, the VARIABLE BANDWIDTH checking can be used. For the example chosen, 5 adjacent spectral lines are averaged between 1000 and 2500 Hz, and 2 adjacent spectral lines are averaged between 200 and 1000 Hz. This averaging increases the effective DOF for plotting and checking purposes in these frequency ranges but not quite by ratios as large as 5 or 2 respectively, because the adjacent line PSD values are not entirely statistically independent.

For the display of control acceleration PSD below, the R.V. TEST SETUP for DEMOTEST was first edited to provide VARIABLE BANDWIDTH

Fig. 4-18



CHECKING. It can easily be seen that there is a significant decrease in the confidence interval in the region from 1 kHz to 2 kHz and a lesser but visible reduction from 200 Hz to 1 kHz, as desired.

4.8 Other Control Keys

During the test runs described in Sections 4.5 and 4.6, the AUTO and MANUAL modes were used. In both of these modes the system is under closed-loop control. The transfer function $|H|$ is updated once each loop time and a new estimate of S_{xx} is used to generate the drive voltage.

In the AUTO mode, the LEVEL is controlled by the LEVEL SCHEDULE, and in the MANUAL mode the LEVEL is controlled by the UP/DOWN CONTROL KEYS in 1 dB increments. The MANUAL mode is entered at the LEVEL of the previous mode of operation. The AUTO mode is entered at the point dictated by the AUTO clock and the LEVEL SCHEDULE. The line item entry for AUTO RAMPING determines the speed at which the proper LEVEL for the AUTO mode is established.

In the OPEN LOOP mode (F7), which was not used during the previously described tests, the system, as the name suggests, is not under closed loop control. The transfer function is updated after the OPEN LOOP mode is established, but the value of S_{xx} used to generate the random drive voltage is left unchanged. The OPEN LOOP mode is entered at the level of the previous mode of operation, and the LEVEL can be controlled by the UP/DOWN CONTROL keys in 1 dB increments.

The action of the (F9-Standby) FUNCTION key is almost identical to that for the ABORT command. The test level decays quickly to zero and the AUTO,MANUAL or OPEN LOOP modes may be reentered immediately. The ABORT mode allows reentry to the AUTO and MANUAL modes as well as restarting the test from the beginning.

For storing data to retrieve at a later time, we have the options at the beginning of the test run (See Section 4.4) to save data, only at the end of the test, to save it periodically during the test run, or not to save it at all. During the test run, regardless of the choice made initially about saving data, we can still save data manually by pressing (F6-Store Data) at any time during the test run. The following chapter examines these options in detail.

4.9 New Features and Additions

The additional line items and entries discussed in Section 3.5 also affect the displays shown in Chapter 4. Other display features have also been added and are discussed in this section.

The applicable input sensitivity (10, 100 or 1000 mV/g) is displayed above the DOF on the right side of all the graphical displays in Figs. 4-1 through 4-18.

The choice of the vibration level (-20 dB to -6 dB) during the calibration sequence is reflected by the display of the CON GRMS value during the calibration sequence. A choice of -20 dB produces a value of approximately 10% of the REF GRMS, although the displayed value may be somewhat different during the initial phases of the calibration sequence, when major equalization changes are taking place. Other choices of vibration level produce proportionately larger displayed values.

The printout of the RANDOM VIBRATION TEST SETUP as shown on p. 4-2 naturally shows these additional line items as well as any (N) entries in the LEVEL SCHEDULE table.

When the segments of the LEVEL SCHEDULE having (N) entries (zero vibration) are actually performed in the test the display shows

STATUS: Auto/Drive = 0

and also

LEVEL: N dB

The PSD display for the previous non-zero test level remains on the graph, however.

An additional transfer function display is provided and is shown under H-DR/CT on the right side of all graphs. Pressing (Alt, 1), (Alt,2)....or (Alt, 8) causes the transfer ratio of the acceleration of the selected input channel to the control channel acceleration to be calculated and displayed. The square root of the selected channel PSD to the control channel PSD is the data actually plotted.

An additional configuration parameter is provided when (F2) is pressed during the test. RMS COMPUTATION appears below GRID DISPLAY in Fig. 4-2. The entries (Full) and (Zoom) may be toggled by the (Enter) key. If the ZOOM frequencies in the fifth and sixth entries in the chart are enabled, the (Zoom) entry for RMS COMPUTATION causes the calculation of RMS values displayed under the REF GRMS to be made with the spectral values between the two "zoom" limit frequencies and <u>not</u> for the full test bandwidth.

5. SAVING AND RETRIEVING DATA

5.1 Introduction

To demonstrate the capabilities of the 400AT for storing and retrieving data, we will run the test setup executed in Chapter 4, except that it has been edited to provide a single-level test at 0 dB for 1 min., 15 sec.

With the R.V. TEST Menu displayed, (F7) is pressed. The default entry (DEMOTEST) is confirmed. The default entry for SAVE TEST DATA is overwritten with (2) and confirmed. The automatically updated default entry for the TEST RUN NAME is confirmed. The HOW OFTEN query is answered with the entries HOURS: 0, MIN: 1, SEC: 0. The resulting display is shown below, just before the final (Enter) initiates the test.

```
                        RANDOM VIBRATION TEST          ver: 10/17/86 14:03:15

F1 = TEST SETUP                              F2 = TEST SEQUENCE SETUP

F3 =                                         F4 =

F5 = TEST DATA                               F6 = TEST SEQUENCE DATA

F7 = RUN TEST                                F8 = RUN TEST SEQUENCE

F9 =                                         F10 = EXIT TO PREVIOUS MENU

RUN TEST SETUP-ID :..............) DEMOTEST
SAVE TEST DATA :.................) 2
    (1=END OF TEST ONLY,2=PERIODICALLY,3=NONE)
TEST RUN NAME (25 char max) :.....) RUN143
HOW OFTEN HOURS:0  MIN:1  SEC: 00

    Esc (Back to Menu)        Enter (Accepts Entry)
```

Fig. 5-1

The choice of periodic data saves above also includes a data save at the end of the test. Note that automatic data saves are made only when the system is in the AUTO mode, because the periodic data saves are based on the AUTO clock which runs in the AUTO mode only. Also the test can end automatically in the AUTO mode only.

5.2 Running the Test

The test was initiated after the final entry for the previous display was confirmed.

After 00:00:22 of the test run has elapsed, (F5) is pressed giving the MANUAL mode and the level is decreased to -7.0 dB. (F6) is pressed to store or save the data. The red LED on the host computer lights intermittently as the data is being transferred to the hard disk. Then (F3) is pressed, returning the system to the AUTO mode.

At exactly 00:01:01 the red LED on the host computer shows that the periodic data save requested is being accomplished.

Finally, at 00:01:15 the test run is over, the Status displays "Finished" and the red LED indicates another data save.

Pressing (F10) causes the R.V. TEST Menu to be displayed again.

5.3 Retrieving the Data

Pressing (F5) provides a display of the R.V. TEST DATA Menu below in Fig. 5-2.

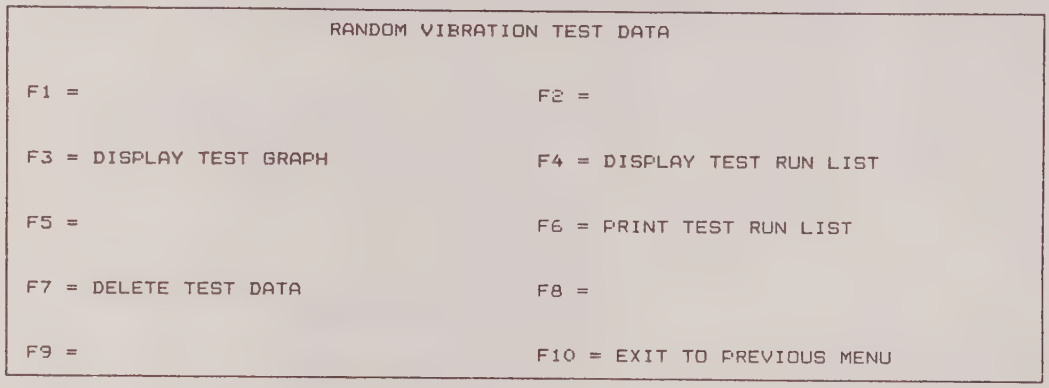


Fig. 5-2

Pressing (F4) provides a display of the DISPLAY TEST RUN LIST Menu, shown in Fig. 5-3. The (Shift, ?) entry provides HELP messages if needed.

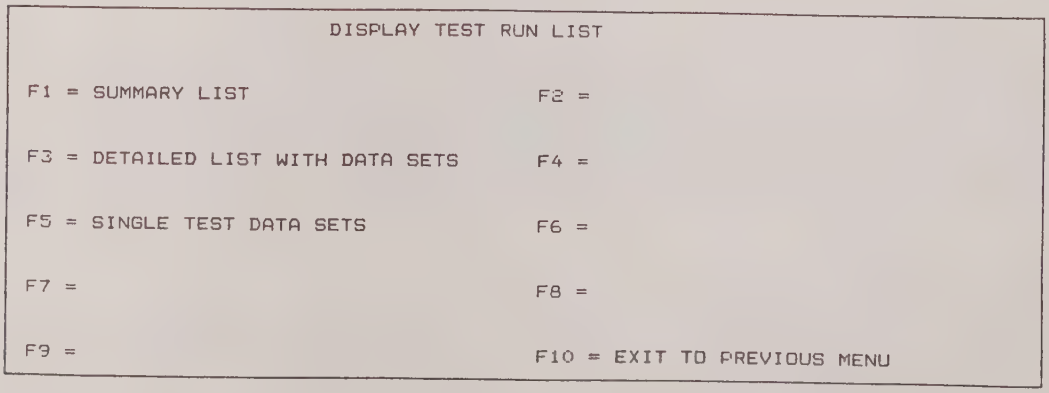


Fig. 5-3

Pressing (F1) displays a list of TEST SETUP ID's and associated RUN NAMES for which data was saved. The date and time the TEST SETUP was last edited and the date and time of the beginning of each TEST RUN is also displayed. Scrolling the display by pressing any key a number of times produces the display for DEMOTEST which is shown in Fig. 5-4. The entry for RUN 143 confirms the data save just made.

SUMMARY LIST OF TEST SETUP and RUN NAMES

TEST SETUP ID		DATE	TIME	RUN-NAME	DATE	TIME
10	DEMOTEST					
	1	32:31.19	05/20/86	8:35	AIP.RUN	05/20/86
	2	1:36:13.	2505/23/	:29:04	VULYZ.RU	N
	3	06/30/86	10:31:12	DPBOXCHECKOUT.001	07/14/86	11:46:16
	4	06/30/86	10:31:12	DPBOXCHECKOUT.007	07/14/86	12:43:50
	5	06/30/86	10:31:12	DPBOXCHECKOUT.013	07/14/86	13:57:53
	6	06/30/86	10:31:12	DPBOXCHECKOUT.019	07/14/86	16:03:00
	7	06/30/86	10:31:12	DPBOXCHECKOUT.025	07/14/86	18:01:16
	8	06/30/86	10:31:12	NEWINTEGRATION.001	07/16/86	15:40:32
	9	06/30/86	10:31:12	RUN1.001	06/30/86	10:34:01
	10	06/17/86	09:01:04	RUN12	06/17/86	10:48:10
	11	06/30/86	10:31:12	RUN12.001	07/16/86	15:45:14
	12	06/30/86	10:31:12	RUN12.007	07/16/86	16:42:41
→	13	11/11/86	11:38:57	RUN143	11/11/86	11:40:49
	14	06/30/86	10:31:12	RUN3.001	07/10/86	16:25:14
	15	05/23/86	17:00:30	RUN327	05/23/86	17:00:36
	16	05/23/86	17:00:30	RUN327	05/23/86	17:00:36
	17	06/30/86	10:31:12	RUN4.001	07/11/86	07:05:19
	18	06/30/86	10:31:12	RUN4.007	07/11/86	08:07:55
	19	06/30/86	10:31:12	RUN4.013	07/11/86	09:13:28

CONTROL KEYS Esc or hit any key to continue

Fig. 5-4

Press (Esc) to return to the DISPLAY TEST RUN LIST Menu and press (F5). Enter (DEMOTEST) and (RUN 143) as shown in Fig. 5-5 after the corresponding queries appear. The list shown in Fig. 5-6 appears and shows the DATA SETS saved when RUN 143 was made. The time in the auto test mode is listed along with the total test time and the test level.

DISPLAY TEST RUN LIST

F1 = SUMMARY LIST F2 =

F3 = DETAILED LIST WITH DATA SETS F4 =

F5 = SINGLE TEST DATA SETS F6 =

F7 = F8 =

F9 = F10 = EXIT TO PREVIOUS MENU

TEST SETUP-ID :.....)DEMOTEST
TEST RUN-NAME :.....)RUN143

Esc (Back to Menu) Enter (Accepts Entry)

Fig. 5-5

```
                    LIST OF TEST SETUP and RUN NAMES

TEST SETUP ID    DATE       TIME          RUN-NAME                    DATE       TIME
                            Auto Time     Total Time    Level
 1  DEMOTEST
       1      11/11/86   11:38:57   RUN143                         11/11/86   11:40:49
                  1      00000:00:01 00000:00:39   0.0 (dB)
                  2      00000:00:22 00000:01:34  -7.0 (dB)
                  3      00000:01:01 00000:02:25   0.0 (dB)
                  4      00000:01:15 00000:02:40   0.0 (dB)
```

Fig. 5-6

Press (Esc) to return to the DISPLAY TEST RUN LIST Menu, and then (F10) to return to the R.V. TEST DATA Menu. Press (F3) which causes the queries below the menu, as shown in Fig. 5-7, to appear.

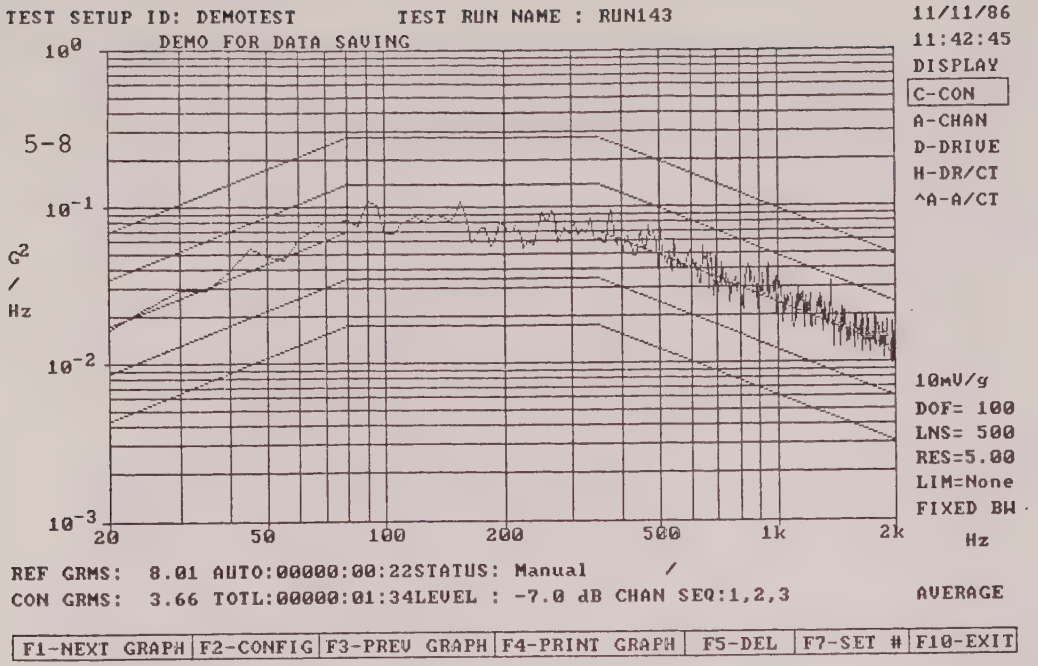
Confirm or enter (DEMOTEST).
Confirm or enter (RUN 143).
Enter (C).
Enter (2), bypassing DATA SET 1 at the beginning of the test run.

```
                        RANDOM VIBRATION TEST DATA

F1 =                                    F2 =

F3 = DISPLAY TEST GRAPH                 F4 = DISPLAY TEST RUN LIST

F5 =                                    F6 = PRINT TEST RUN LIST

F7 = DELETE TEST DATA                   F8 =

F9 =                                    F10 = EXIT TO PREVIOUS MENU

TEST SETUP-ID :.............)DEMOTEST
TEST RUN-NAME :.............)RUN143
DISPLAY TEST PARAMETER :.....)C
     (C=CONTROL,A=ANALYSIS,D=DRIVE,H=DRIVE/CT)
TEST DATA SET NUMBER.........)2

    Esc (Back to Menu)      Enter (Accepts Entry)
```

Fig. 5-7

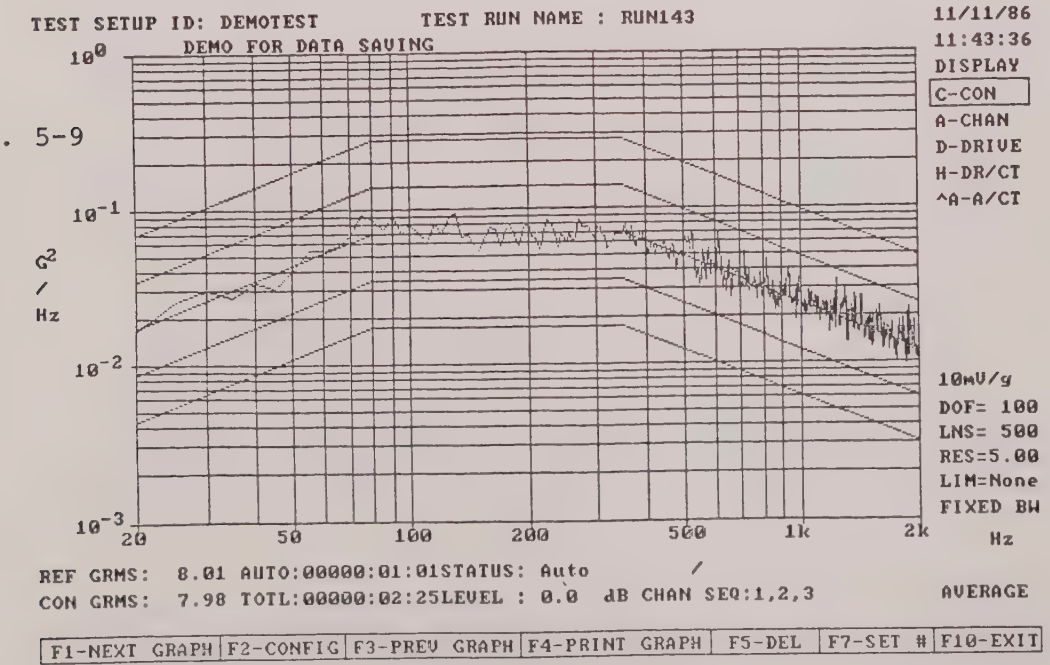
Just after (2) is entered, the graph shown in Fig. 5-8 for the PSD of the multiplexed control signal appears. Note the function key descriptors at the bottom of the display.

Fig. 5-8



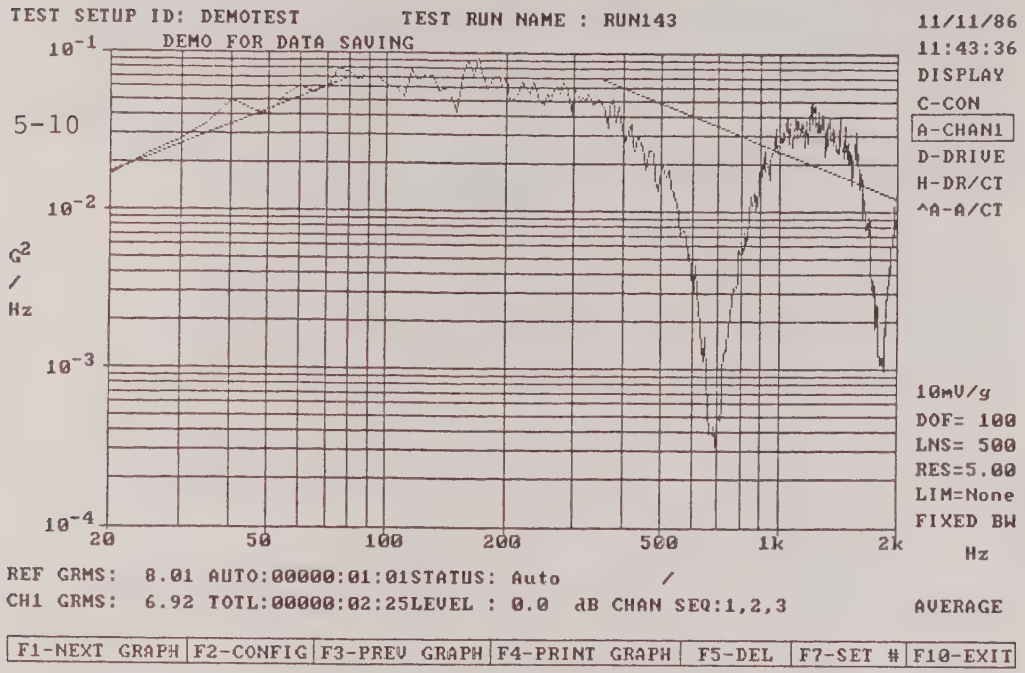
Four other graphs could be viewed by typing (A), (D) or (H) or (Alt,A). (F3) would display the data set taken at 0:0:01. Pressing (F1) displays data set 3 taken at 0:1:01. The next five graphs represent all the stored data taken at 0:1:01.

Fig. 5-9



Type (A) to display the graph below for the PSD of Channel 1.

Fig. 5-10



Type (D) to display the graph for the drive voltage PSD, then (H) for the graph of the shaker transfer function in V/g.

Fig. 5-11

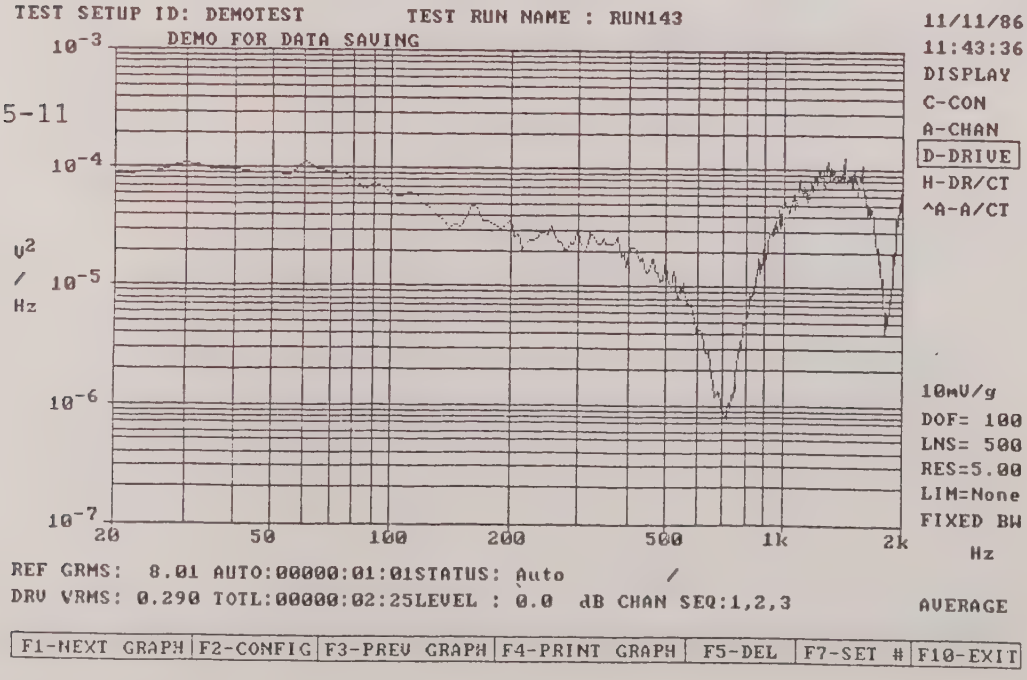
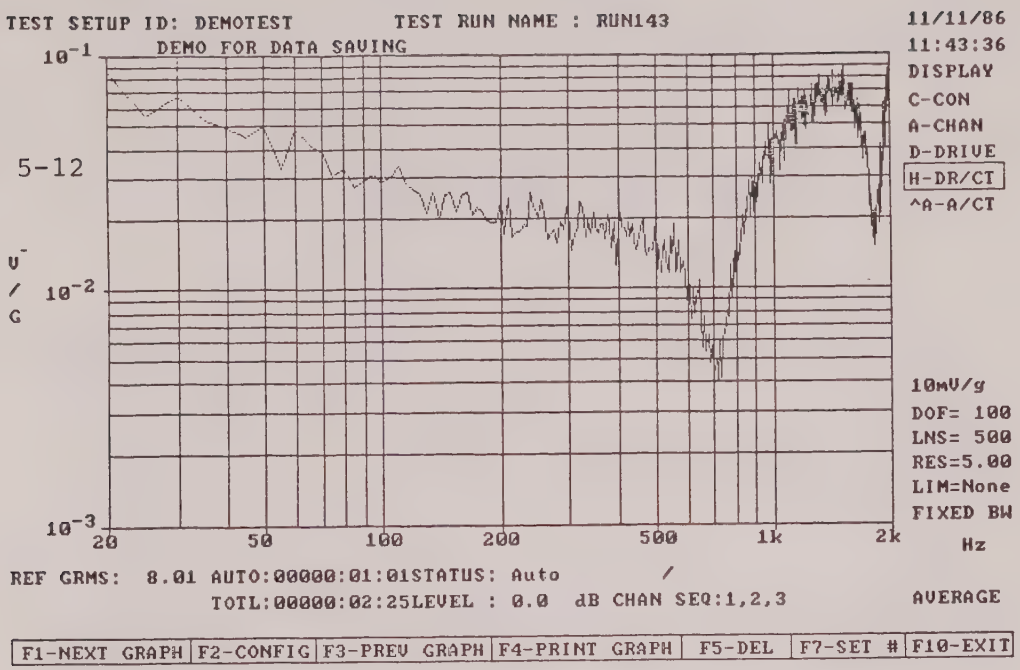
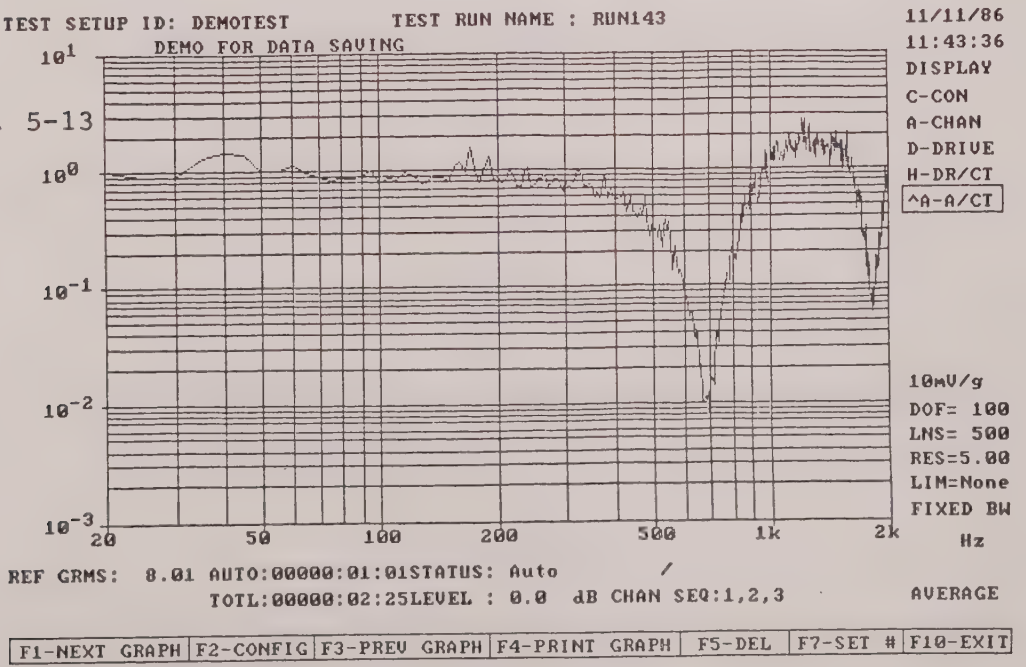


Fig. 5-12



Finally, pressing (Alt,A) displays the transfer ratio of channel 1 acceleration to control acceleration in either $(g/g)^2$ or g/g. For this data set, this ratio has little physical meaning because the control acceleration is a multiplexed signal.

Fig. 5-13



The configuration of any graph may also be changed. Pressing (F2) causes the configuration parameters to scroll down in place of the graph. The following parameters are changed for the control PSD so as to provide detailed information around 2 kHz shown in Fig. 5-14.

ZOOM----------> Yes
FROM (Hz)-----> 1950
TO (Hz)-------> 2050
CURSOR--------> Yes

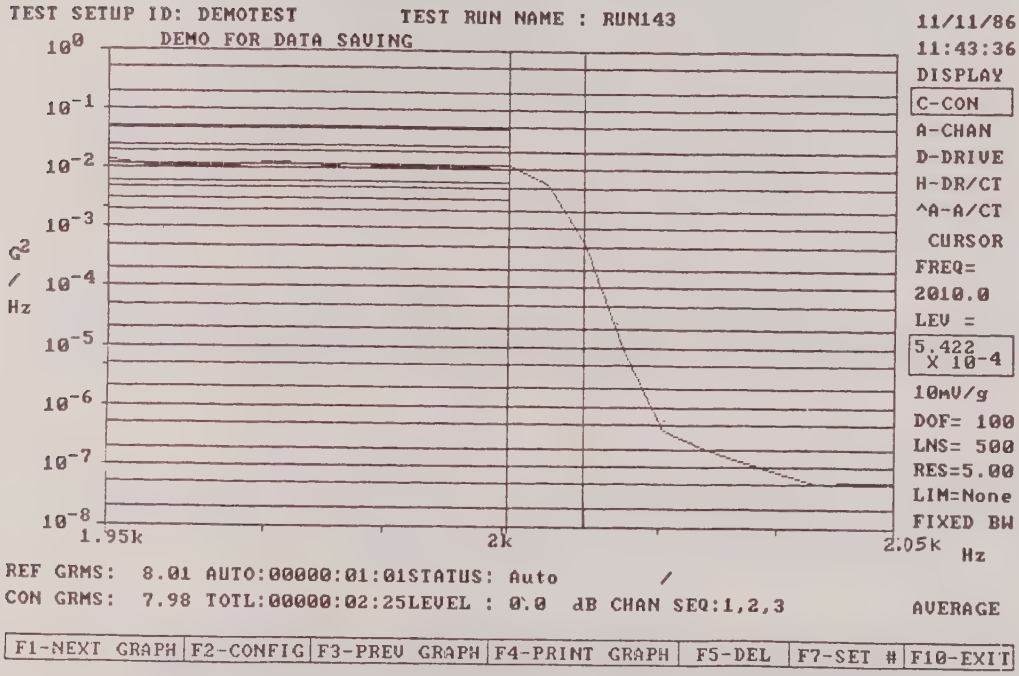


Fig. 5-14

The display in Fig. 5-14 shows that several spectral line widths are necessary for the PSD to decrease approximately 40 dB from 2000 Hz to 2020 Hz. This is due to the effective frequency response overlap effects of the analysis filters provided by Hanning windowing and the FFT process.

The graph from the final data save taken after the TEST RUN was finished at 00:1:15 is obtained by:

Pressing (F2) to reconfigure the Control PSD by changing

ZOOM----- > No
CURSOR--- > No

Pressing (End) and then (F1) to obtain the end-of-test control PSD (at 00:1:15) found in Fig. 5-15.

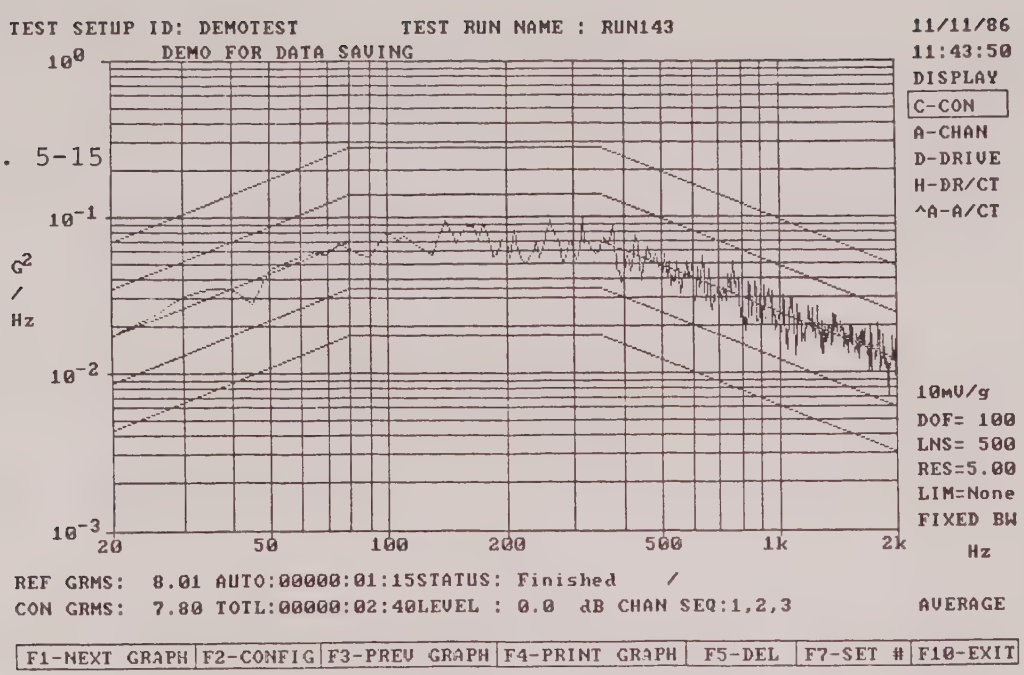


Fig. 5-15

Four other graphs are available for:
(A)-Channel 1 PSD;
(D)-Drive Voltage PSD;
(H)-Transfer function (Drive voltage PSD/Control PSD);
(Alt,A) - Channel 1 PSD/Control PSD,
but are not shown to conserve space. Practice can be had scanning the saved data by exercising the (F1), (F3), (C), (A), (D), (H) and (Alt,A) keys.

It is worth noting that only one of the PSD's for the multiple control channels can be retained for each data save. The system normally saves data for the first channel in the CHAN. SEQ. entry, but if another channel PSD is viewed during the test run, subsequent data saves will save the data of the channel most recently viewed.

5.5 Summary

All data saves that are initiated by the response to the SAVE TEST DATA query at the beginning of each TEST RUN are accomplished when the system is in the AUTO mode only. Such data saves may be made at the end of the test run only, or periodically and also at the beginning and end of the test run. The periodic saves may be made no more frequently than every 30 s or an error message will appear.

Any data saves made when the system is in the MANUAL or OPEN LOOP modes must be commanded by the operator during the test run by pressing (F6). Additional data saves may of course be made in the AUTO mode by pressing (F6) at the appropriate time during the test run.

6. COPYING OPERATIONS

Obtaining periodic copies on floppy disks of important TSET SETUP information, TEST SEQUENCES and saved TEST DATA from the system hard disk is an important part of system operation. This BACKUP operation can save many hours of reconstructive labor, should important information be inadvertently deleted from the hard disk. The complementary or RESTORE operation occurs when files on floppy disks are recopied to the system hard disk. The organization and techniques of making such copies are described in this chapter.

Obtain the MAJOR OPERATIONAL MODES Menu below:

```
                    MAJOR OPERATIONAL MODES

F1 = RANDOM TEST                    F2 = REMOTE/KEYBOARD

F3 = SINE TEST                      F4 = MEASUREMENT/ANALYZE

F5 =                                F6 = MAINTENANCE/CONFIGURATION

F7 = SHOCK TEST                     F8 = HELP

F9 =                                F10 = EXIT
```

SELECT A FUNCTION KEY

Press (F6) to obtain the MAINTENANCE/CONFIGURATION Menu below:

```
                MAINTENANCE/CONFIGURATION     ver: 10/05/89 11:34:02

F1 = HARDWARE CONFIGURATION         F2 = OPERATOR ACCESS

F3 = DATE/TIME                      F4 =

F5 = BACKUP                         F6 = RESTORE

F7 = RESET RANDOM RUN COUNTER       F8 = DEFAULT TEST ENTRIES

F9 =                                F10 = EXIT
```

SELECT A FUNCTION KEY

Press (F5) to obtain the BACKUP TYPE Menu shown below. This Menu lists the various types of test methods for which there may be stored information.

BACKUP TYPE	
F1 = RANDOM	F2 =
F3 = SINE	F4 = MEASURE/ANALYZE
F5 =	F6 =
F7 = SHOCK	F8 =
F9 =	F10 = EXIT TO PREVIOUS MENU

SELECT A FUNCTION KEY

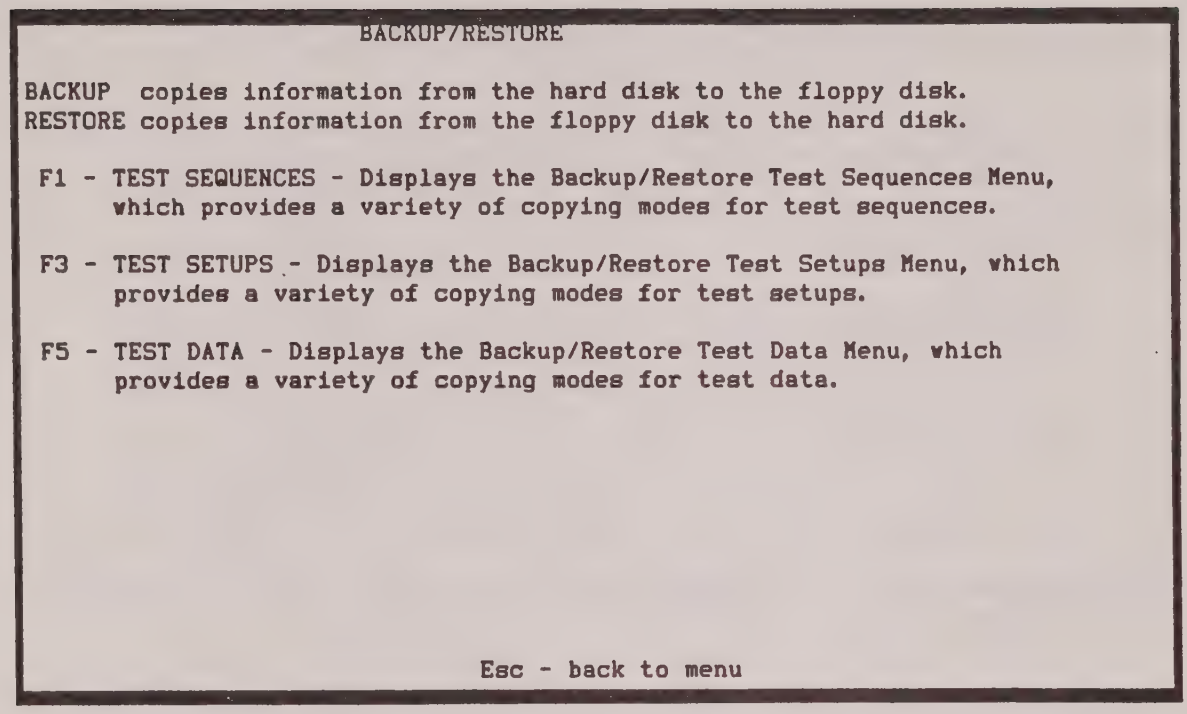
Press (F1) to display the BACKUP RANDOM TESTS Menu below:

BACKUP RANDOM TESTS	
F1 = TEST SEQUENCES	F2 =
F3 = TEST SETUPS	F4 =
F5 = TEST DATA	F6 =
F7 =	F8 =
F9 =	F10 = EXIT TO PREVIOUS MENU

SELECT A FUNCTION KEY

?-Help ---

Press (Shift,?) to obtain the HELP page on p.6-3. it contains a description of the categories of information stored for RANDOM TESTS.


BACKUP/RESTORE
BACKUP copies information from the hard disk to the floppy disk.
RESTORE copies information from the floppy disk to the hard disk.
F1 - TEST SEQUENCES - Displays the Backup/Restore Test Sequences Menu, which provides a variety of copying modes for test sequences.
F3 - TEST SETUPS - Displays the Backup/Restore Test Setups Menu, which provides a variety of copying modes for test setups.
F5 - TEST DATA - Displays the Backup/Restore Test Data Menu, which provides a variety of copying modes for test data.
Esc - back to menu

This HELP display, and all following HELP displays, are common to both BACKUP and RESTORE operations for all types of tests. The menus for all BACKUP and RESTORE operations are identical except for the implied direction of the copying action. If (F6) had been chosen from the MAINTENANCE/CONFIGURATION Menu on p.6-1, all following menus would have had RESTORE instead of BACKUP in their titles.

Similarly, if (F3) had been chosen from the BACKUP TYPE Menu on p.6-2, then all following menus would relate to SINE vibration tests instead of RANDOM vibration tests.

For these reasons, the menus for the RESTORE choice on the MAINTENANCE/CONFIGURATION Menu on p.6-1, and the SINE, SHOCK or MEASURE/ANALYZE choices from either the BACKUP or RESTORE Menus (See p.6-2) will not be reproduced in the remainder of this chapter.

Press (E-c) to return to the BACKUP RANDOM TESTS Menu.
Continue on p.6-4.

Press (F1) to display the BACKUP TEST SEQUENCES Menu below:

```
                    BACKUP TEST SEQUENCES

F1 = COPY ONE SEQUENCE AT A TIME        F2 = DISPLAY SEQUENCE IDS
                                             CHRONOLOGICALLY

F3 = COPY ALL SEQUENCES                 F4 = DISPLAY SEQUENCE IDS
                                             ALPHABETICALLY

F5 = COPY ALL SEQUENCES SINCE ____      F6 = PRINT SEQUENCE IDS
                                             CHRONOLOGICALLY

F7 = COPY ONE SEQUENCE RUN              F8 = PRINT SEQUENCE IDS
                                             ALPHABETICALLY

F9 =                                    F10 = EXIT TO PREVIOUS MENU
```

SELECT A FUNCTION KEY

?-Help

Note that these operations relate to RANDOM TEST SEQUENCES only.

Press (Shift,?) to obtain the common HELP displays on p.6-5

BACKUP/RESTORE TEST SEQUENCES MENU

Copying action is initiated by F1,F3,F5 or F7. To help the operator decide on appropriate copying action, lists of all test sequence IDs are presented by F2,F4,F6 and F8, along with the approximate number of sequences that may be stored on each disk.
After selecting either F1,F3 or F5, the operator must decide whether or not to copy all test setups listed by the sequence(s) he has decided to copy. A copy of the sequences merely provides a list of the test setup IDs associated with each sequence and not the test setup parameters. In order to include enough information to actually perform test sequences it is necessary to copy the test setups also.

F1 - COPY ONE SEQUENCE AT A TIME - Enter the appropriate test sequence ID, and respond to the additional question outlined above.

F3 - COPY ALL SEQUENCES - Respond to the additional question outlined above.

F5 - COPY ALL SEQUENCES SINCE _____ - Enter the appropriate date and respond to the additional question outlined above. This is valuable for periodic backup operations.

PgDn - to continue Esc - back to menu

Press (PgDn) to display the final HELP page below:

BACKUP/RESTORE TEST SEQUENCES MENU

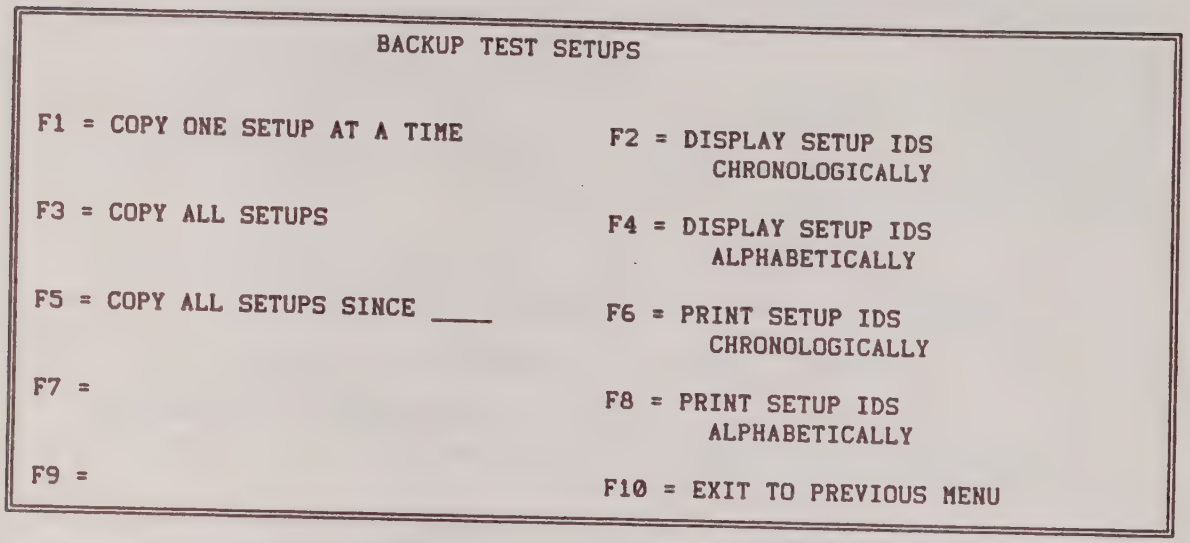
F7 - COPY ONE SEQUENCE RUN - Allows copying of all data saved during one run of a sequence. Enter the test sequence ID and the run name. The appropriate run numbers (.001, .002, etc.) will be automatically added to this run name to copy the saved data for each test run in the sequence.

If a floppy disk fills up in the middle of copying a group of files (BACKUP action), the operator is asked to insert a new disk and the copying action will continue after a prompt to format or not to format. Formatting initializes a disk and destroys all data on the disk. New disks need to be formatted before they can be used.

PgUp - back up one screen Esc - back to menu

Press (Esc), then (F10) to return to the BACKUP RANDOM TESTS Menu on p.6-2. Continue on p.6-6.

Press (F3) to obtain the BACKUP TEST SETUPS Menu below:


BACKUP TEST SETUPS
F1 = COPY ONE SETUP AT A TIME
F2 = DISPLAY SETUP IDS CHRONOLOGICALLY
F3 = COPY ALL SETUPS
F4 = DISPLAY SETUP IDS ALPHABETICALLY
F5 = COPY ALL SETUPS SINCE ____
F6 = PRINT SETUP IDS CHRONOLOGICALLY
F7 =
F8 = PRINT SETUP IDS ALPHABETICALLY
F9 =
F10 = EXIT TO PREVIOUS MENU

SELECT A FUNCTION KEY

?-Help

Press (Shift,?) to obtain the HELP displays on p.6-7

BACKUP/RESTORE TEST SETUP MENU

Copying action is initiated by F1,F3, or F5. To help the operator decide on appropriate copying action, lists of all test setup IDs are presented by F2,F4,F6 and F8, along with the approximate number of setups that may be stored on each disk.
After selecting either F1,F3 or F5, the operator must decide whether or not to copy all test data associated with the test setups before actual copying is initiated.

F1 - COPY ONE SETUP AT A TIME - Enter the appropriate test setup ID, and respond to the additional question concerning test data.

F3 - COPY ALL SETUPS - Respond to the additional question concerning test data.

F5 - COPY ALL SETUPS SINCE _____ - Enter the appropriate date and respond to the additional question concerning test data. This is valuable for periodic backup operations.

PgDn - to continue Esc - back to menu

Press (PgDn) for the final HELP display below:

BACKUP/RESTORE TEST SETUP MENU

If a floppy disk fills up in the middle of copying a group of files (BACKUP action), the operator is asked to insert a new disk and the copying action will continue after a prompt to format or not to format. Formatting initializes a disk and destroys all data on the disk. New disks need to be formatted before they can be used.

PgUp - back up one screen Esc - back to menu

Press (Esc), then (F10), to return to the BACKUP RANDOM TESTS Menu on p.6-2. Continue on p.6-8.

Press (F5) to obtain the BACKUP TEST DATA Menu below:

```
                        BACKUP TEST DATA

F1 = COPY DATA - ONE RUN AT A TIME      F2 = DISPLAY RUN NAMES
                                              IN CHRONOLOGICAL ORDER

F3 = COPY ALL TEST DATA                 F4 = DISPLAY RUN NAMES
                                              WITH ALPHABETICAL SETUP IDS

F5 = COPY ALL TEST DATA SINCE ____      F6 = PRINT RUN NAMES
                                              IN CHRONOLOGICAL ORDER

F7 =                                    F8 = PRINT RUN NAMES
                                              WITH ALPHABETICAL SETUP IDS

F9 =                                    F10 = EXIT TO PREVIOUS MENU

  SELECT A FUNCTION KEY

?-Help
      ------------------------------------------------------------
```

Press (Shift,?) to obtain the HELP displays on p.6-9.

BACKUP/RESTORE TEST DATA MENU

Copying action is initiated by F1,F3, or F5. To help the operator decide on appropriate copying action, lists of all test setup IDs and the run names for saved data associated with them are presented by F2,F4,F6 and F8, along with the approximate number of data saves that may be stored on each disk.

F1 - COPY ONE RUN NAME AT A TIME - Enter the appropriate test setup ID, and the run name for the saved data. Note that the test setup ID is always necessary because run names for saved test data may be identical for two different test setups. After copying is completed, the request for another test setup ID and run name will be made.

F3 - COPY ALL TEST DATA - The copying of the entire collection of saved test data is initiated.

F5 - COPY ALL TEST DATA SINCE _____ - Enter the appropriate date (month/day/year). Test data saved since that date will be copied.

PgDn - to continue Esc - back to menu

Press (PgDn) to obtain the final HELP display below:

BACKUP/RESTORE TEST DATA MENU

If a floppy disk fills up in the middle of copying a group of files (BACKUP action), the operator is asked to insert a new disk and the copying action will continue after a prompt to format or not to format. Formatting initializes a disk and destroys all data on the disk. New disks need to be formatted before they can be used.

F2 & F6 - DISPLAY/PRINT RUN NAMES IN CHRONOLOGICAL ORDER - The run names along with the associated test setup IDs are displayed or printed in order according to the dates the data was saved.

F4 & F8 - DISPLAY/PRINT RUN NAMES WITH ALPHABETICAL SETUP IDS - The run names for saved data are displayed/printed with the associated test setup IDs and the test setup IDs are sorted in alphabetical order. Dates for the run names are also listed.

PgUp - back up one screen Esc - back to menu

Press (Esc), then (F10), to return to the BACKUP RANDOM TESTS Menu on p.6-2.

The basic excursion through the menus for the BACKUP operation is now complete. You may, however, want to EXIT to the MAINTENANCE/ CONFIG. Menu on p.6-1 and explore similar paths for the RESTORE operation to satisfy yourself of the properties noted on p.6-3.

The remainder of the chapter gives an example of an actual copying operation.

A floppy disk was inserted in the front slot of the Host Computer, and the locking handle rotated vertically. The BACKUP RANDOM TESTS Menu shown on p.6-2 was obtained. By pressing (F3), the BACKUP TEST SETUPS Menu was displayed. To aid in the BACKUP operation, the list of the saved TEST SETUPS shown below was obtained by pressing (F6).

Note the estimate for available space on both disks at the bottom of the printout. If the floppy disk had not been inserted initially, room available for "0" test setups on the floppy disk would have been reported.

```
   TEST SETUP                    DATE     TIME
 1 DEMOTEST                   05/20/86 12:56:57
 2 FLATTEST                   05/14/86 10:27:14
 3 AIRPAX                     05/02/86 11:09:28
 4 FLAT                       05/01/86 13:58:44
 5 GE                         04/29/86 12:59:29
 6 BOEING                     04/24/86 11:00:53
 7 SINE                       04/21/86 07:33:22
 8 250TEST                    04/14/86 13:39:07
 9 625TEST                    04/14/86 13:22:14
10 1250TEST                   04/14/86 12:10:59
11 BENCHMAR                   04/03/86 09:56:30
12 HUGHES2                    03/17/86 13:18:47
13 CHRYSLER                   03/17/86 09:24:09
14 SPERRY                     02/19/86 04:10:57
15 M2022142                   01/22/86 15:41:23
16 M2022141                   01/22/86 15:40:51
17 RAYTHEON                   01/09/86 20:02:31
ROOM AVAILABLE FOR 3064 TEST SETUPS ON HARD DISK
ROOM AVAILABLE FOR 73 TEST SETUPS ON FLOPPY DISK
```

Next, the decision to press (F5 = COPY ALL SETUPS SINCE ---) was made to illustrate how a periodic BACKUP operation might be started. Upon pressing (F5), the date query appeared below the Menu as shown on p.6-11.

```
                    BACKUP TEST SETUPS

F1 = COPY ONE SETUP AT A TIME          F2 = DISPLAY SETUP IDS
                                            CHRONOLOGICALLY

F3 = COPY ALL SETUPS                   F4 = DISPLAY SETUP IDS
                                            ALPHABETICALLY

F5 = COPY ALL SETUPS SINCE ____        F6 = PRINT SETUP IDS
                                            CHRONOLOGICALLY

F7 =                                   F8 = PRINT SETUP IDS
                                            ALPHABETICALLY

F9 =                                   F10 = EXIT TO PREVIOUS MENU
```

```
COPY ALL SETUPS SINCE DATE: MONTH: 4 DAY: 16 YEAR: 86
ALSO COPY ALL TEST DATA ASSOCIATED WITH THE SETUP(S)? (Y,N) : N

    Esc (Back to Menu)       Enter (Accepts Entry)
```

The date 04/16/86 was entered and the query concerning copying all related test data appeared. An "N" (No) response was entered. During the copying action, the test setup being copied appears at the bottom of the display. The display shown below occurred while the "GE" test setup was being copied.

```
                    BACKUP TEST SETUPS

F1 = COPY ONE SETUP AT A TIME          F2 = DISPLAY SETUP IDS
                                            CHRONOLOGICALLY

F3 = COPY ALL SETUPS                   F4 = DISPLAY SETUP IDS
                                            ALPHABETICALLY

F5 = COPY ALL SETUPS SINCE ____        F6 = PRINT SETUP IDS
                                            CHRONOLOGICALLY

F7 =                                   F8 = PRINT SETUP IDS
                                            ALPHABETICALLY

F9 =                                   F10 = EXIT TO PREVIOUS MENU
```

```
COPY ALL SETUPS SINCE DATE: MONTH: 4 DAY: 16 YEAR: 86

COPYING SETUP GE
    Esc (Back to Menu)       Enter (Accepts Entry)
```

At the end of the BACKUP operation the display shown below appears. The number of files copied appears at the bottom of the display, and agrees with the number expected from the TEST SETUP list shown on p.6-10 and the entry date 4/16/86.

```
                        BACKUP TEST SETUPS

F1 = COPY ONE SETUP AT A TIME          F2 = DISPLAY SETUP IDS
                                            CHRONOLOGICALLY
F3 = COPY ALL SETUPS                   F4 = DISPLAY SETUP IDS
                                            ALPHABETICALLY
F5 = COPY ALL SETUPS SINCE ____        F6 = PRINT SETUP IDS
                                            CHRONOLOGICALLY
F7 =                                   F8 = PRINT SETUP IDS
                                            ALPHABETICALLY
F9 =                                   F10 = EXIT TO PREVIOUS MENU

 SELECT A FUNCTION KEY

COPY COMPLETE - 7 FILES BACKED UP
?-Help
```

After the "COPY COMPLETE" message is displayed and the red LED near the floppy insert slot is OUT, the floppy disk may be removed from the Host. When the red LED is ON, the floppy disk should not be disturbed.

When the copying is initiated after the response to the TEST DATA query shown on p.6-11 is entered, the statement and query shown below often appears just below the Menu. See HELP display on p.6-7. The decision to format the disk by entering "Y" will usually cause the copying action described earlier to be completed.

```
CAN'T CREATE BACKUP FILE. FLOPPY DISK MAY NEED TO BE FORMATTED (INITIALIZED)
OR MAY BE OF WRONG TYPE. FORMATTING DESTROYS ALL DATA ON THE DISK.
FORMAT DISK? (Y,N) : Y

    Esc (Back to Menu)        Enter (Accepts Entry)
```

Some problem, however, may prevent the formatting from being carried out. In this case the message shown below appears below the Menu.

```
DISK CAN'T BE USED. INSERT A NEW ONE AND PRESS ANY KEY TO CONTINUE
```

7. MEASUREMENT AND ANALYSIS OF SIGNALS

7.1 Introduction

In addition to its use as a vibration control system, the 400AT can also be used to perform dual channel measurement and analysis functions for a variety of signals. The two signals are menu-selected from as many as eight signals applied to the input connectors of the UD320.

If the MEASUREMENT/ANALYZE Option has been supplied with the 400AT/R Random Vibration Control System, asynchronous capture of two signals from the field of eight signals is possible. Continuously updated displays of the time functions, PSD's and transfer function (PSD ratio) are available. Hanning input windowing is standard. Due to the asynchronous capture, this option is best used with continuous signals. A stored PSD from the capture mode may also be used as a reference PSD for a RANDOM TEST SETUP. See p. 3-16 of the 400AT/R Instruction Manual for this application.

With the 400AT/S Transient/Shock Vibration Control System, triggered capture of two signals from the field of eight input signals is standard. Automatic rearming of the trigger or manual rearming of the trigger after each data capture may be selected. Display of the time functions, FFT's or SRS's may be selected. This option is best used with transient and continuous periodic signals.

A stored time function from either capture mode may be used as an acceleration reference function for a SHOCK TEST SETUP. See Section 3.8 of the 400AT/T Instruction Manual for this application.

7.2 Initial Procedure - Connections

Interconnections between the components of the 400AT Vibration Control System are discussed in Chapter 2. If there are input connectors of the UD320 that are not used for control purposes, these may be used to accept signals from tape recorders, signal generators or vibration signal conditioners connected to other active control systems. Vibration control and signal measurement/analysis cannot be conducted simultaneously with a 400AT System.

If all eight inputs of the UD320 (See Fig. 2-1) are used for control purposes, it is necessary to disconnect enough cables from the input connectors of the UD320 to accommodate connections from the signal sources to be analyzed. Voltage sources should be connected directly to the 10mV/g BNC connectors and the selector switches toggled to the "down" position to select the voltage inputs.

It is not necessary that the input sensitivity be 10mV/g, as the calibration constant may be set to the actual value in one of the menus. A charge source such as a piezoelectric accelerometer may be connected directly to the 10-32 miniature input connector, and the switch toggled to the "up" position, if the charge converter option has been supplied. The accelerometer sensitivity need not be 10pC/g. The scaling of the time functions and the PSD's may be directly in volts and volts sq./Hz if the voltage does not represent an acceleration.

The maximum input voltage is ±10 V pk, and the maximum charge input is ±10,000 pC pk at the corresponding input connectors.

Make sure that the AC power to all components of the 400AT System is on. The power amplifier in the VTS need not be turned on, but it may be necessary to press the PREAMP ON button on the amplifier console to apply power to the 400AT system, if the 400AT receives power from the 120VAC power strip inside the amplifier cabinet.

Within a minute after the power is turned on, the 400AT System Logo appears on the Color Monitor, and we are ready to demonstrate operation of the MEASUREMENT/ANALYZE Mode.

7.3 Major Menus

Press any key to obtain the MAJOR OPERATIONAL MODES Menu below:

Fig.7-1

```
                    MAJOR OPERATIONAL MODES

F1 = RANDOM TEST                    F2 = REMOTE/KEYBOARD

F3 = SINE TEST                      F4 = MEASUREMENT/ANALYZE

F5 = SINE ON RANDOM TEST            F6 = MAINTENANCE/DIAGNOSTICS

F7 = SHOCK TEST                     F8 = HELP

F9 = RANDOM ON RANDOM TEST          F10 = EXIT

SELECT A FUNCTION KEY
```

Then press (F4) to obtain the MEASUREMENT/ANALYZE Menu below:

Fig.7-2

```
                    MEASUREMENT/ANALYZE          ver: 12/8/87

F1 = ANALYZE SIGNAL(s)              F2 = RENAME

F3 = DISPLAY SAVED DATA             F4 = DISPLAY DATA SAVE LIST

F5 =                                F6 = PRINT DATA SAVE LIST

F7 = CAPTURE SIGNAL (s)             F8 = DELETE

F9 = COPY                           F10 = EXIT TO PREVIOUS MENU

SELECT A FUNCTION KEY

?-Help
```

Press (Shift,?), and then (PgDn) to obtain the two HELP pages, which follow:

Fig.7-3

```
                        ANALYZER MENU

F1 - ANALYZE SIGNAL(s) - Allows continuous non-synchronized capture of as
     many as two signals applied to the UD320. Viewing of these signals and
     their PSD's is provided.

F2 - RENAME - Changes the ID for saved data to a new ID.

F3 - DISPLAY SAVED DATA - Displays saved PSD's and time frames for as many as
     two signals. The default entry for the ID represents the most recently
     saved data. It may be overwritten.

F4 - DISPLAY DATA SAVE LIST - Displays a list of all ID's sorted
     alphabetically, with the time and date that each was created.

F6 - PRINT DATA SAVE LIST - Prints a list of all ID's sorted
     alphabetically, with the time and date that each was created.

F7 - CAPTURE SIGNALS(s) - Allows the capture of as many as two signals
     applied to the UD320 by means of a variable delay trigger. Viewing the
     captured signals and their FFT's and SRS's is provided. Used for
     transient and continuous signals.
         PgDn - to continue      Esc - back to menu
```

Fig.7-4

```
                        ANALYZER MENU

F8 - DELETE - Deletes the data corresponding to the entered ID from the hard
     disk.

F9 - COPY - Copies data associated with a given ID and provides a new ID. The
     data and the original ID are not altered.

          PgUp - back up one screen      Esc - back to menu
```

Pressing (F2-Rename), (F8-Delete) or (F9-Copy) causes queries for appropriate ID entries to appear below the MEASUREMENT/ANALYZE Menu. We will examine in detail the action caused by the (F1-Analyze Signal(s)) and (F7-Capture Signal(s)) commands in the following sections.

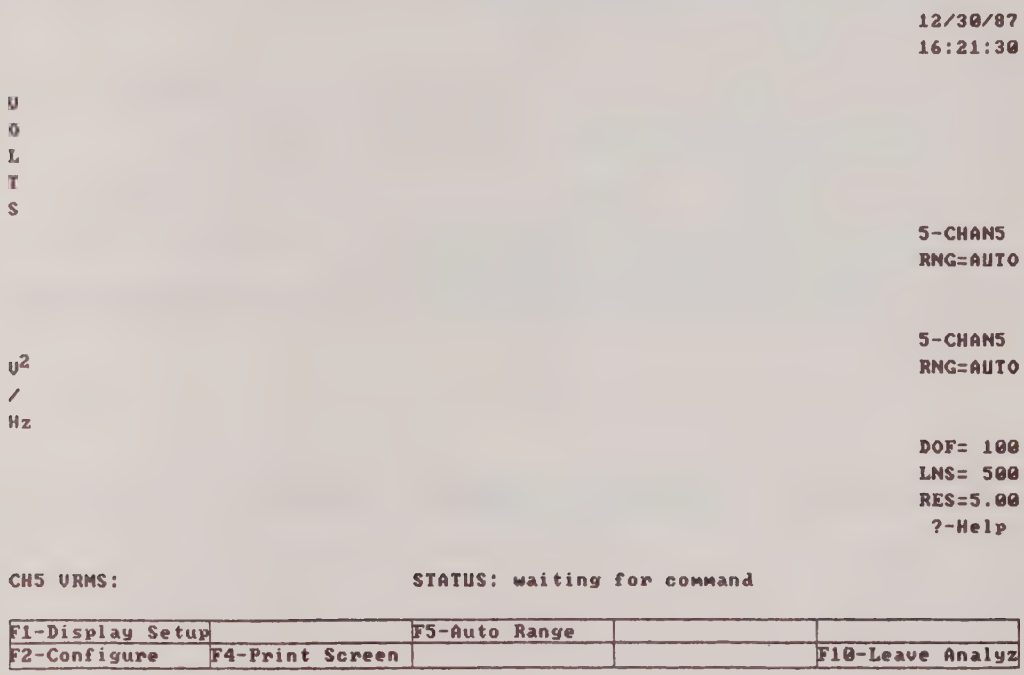
Press (Esc) to return to the MEASUREMENT/ANALYZE Menu in Fig.7-2.

7.4 Asynchronous Signal Capture (ANALYZE SIGNAL(s))

In order to demonstrate the operation for asynchronous signal capture, the random output signal from a UD Model SG-36 Spectrum Generator was applied to the 10mV/g input for channel 5 on the UD320. The spectrum adjustment controls on the SG-36 were set to provide a wide variation in the output PSD over the frequency band from 10 to 2000 Hz.

Then (F1-Analyze Signal(s)) was pressed, which generated the blank graphical display in Fig.7-5.

Fig.7-5



Immediately after, (Shift,?) was pressed to display the first HELP page, which describes the action of the Function Keys, and is shown in Fig.7-6. Pressing (PgDn) twice displays the two remaining HELP pages.

Fig.7-6

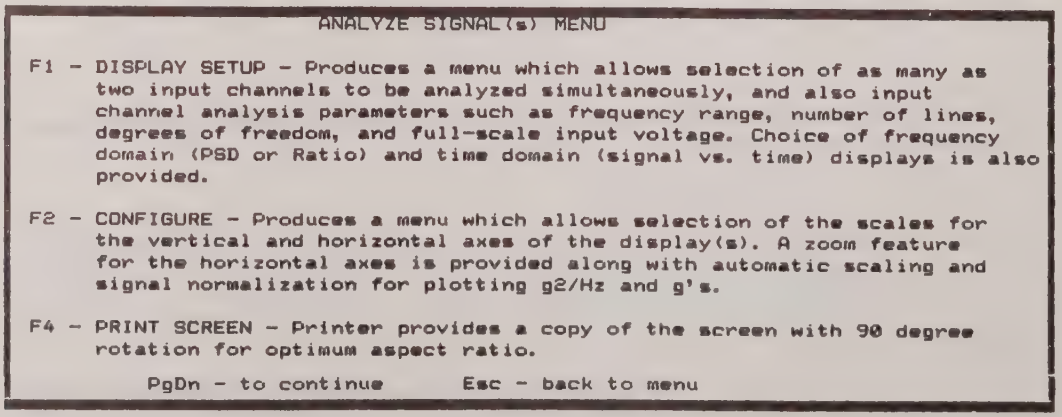

ANALYZE SIGNAL(s) MENU
F1 - DISPLAY SETUP - Produces a menu which allows selection of as many as two input channels to be analyzed simultaneously, and also input channel analysis parameters such as frequency range, number of lines, degrees of freedom, and full-scale input voltage. Choice of frequency domain (PSD or Ratio) and time domain (signal vs. time) displays is also provided.
F2 - CONFIGURE - Produces a menu which allows selection of the scales for the vertical and horizontal axes of the display(s). A zoom feature for the horizontal axes is provided along with automatic scaling and signal normalization for plotting g2/Hz and g's.
F4 - PRINT SCREEN - Printer provides a copy of the screen with 90 degree rotation for optimum aspect ratio.
PgDn - to continue
Esc - back to menu

Fig.7-7

```
                    ANALYZE SIGNAL(s) MENU

F5 - AUTO RANGE - Press to re-estimate and reset the gain of the analyzer
     when an input level or spectral content is changed. This optimizes the
     signal level at the input to the digital processor for maximum signal
     to noise ratio and resets the PSD averagers for minimum analysis time.
     The vertical axes for the displays are automatically adjusted before
     the new displays are presented.

F6 - STORE DATA - Saves the PSD and one time frame for each signal being
     analyzed. Entry of a data save ID is required.

F7 - AUTO SCALE - Press to re-estimate and adjust the scale on the vertical
     axes to best display the time and/or frequency data. This command and
     also the F5 command override and change fixed full scale range and scale
     entries on the DISPLAY SETUP and CONFIGURE DISPLAY MENUS.

F9 - HOLD/CONT DISPLAY - Press to hold the display and prevent updating if it
     is desired to examine the display(s) in detail with the cursor. This is
     particularly necessary for any time display. Once pressed, the F9 key
     command then changes to CONT DISPLAY. Press to continue updating the
     display(s)
         PgDn - to continue        Esc - back to menu
```

Fig.7-8

```
                    ANALYZE SIGNAL(s) MENU

F10 - LEAVE ANALYZE - Returns to the previous menu.

↑ ↓ - The cursor appears in one display at a time. The up and down arrow
      keys move the cursor from one display to the other.

(- -)  - Momentary action moves the cursor one data point to the right or
         left. Holding the key down causes repetitive action. Depressing
         the shift key simultaneously causes the cursor to move several
         data points at a time.

         PgUp - back up one screen      Esc - back to menu
```

Pressing (Esc) and then (F1) immediately after, produces the DISPLAY SETUP Menu in Fig.7-9. The selections describe the display parameters which are also listed around the borders of the graphs in Figs.7-5 and 7-9.

Fig.7-9

```
                                                              12/30/87
                                                              16:23:34
V
O
L
T
S
        DISPLAY(s) <Upper,Lower,Both>.....>BOTH
        UPPER DISPLAY <FREQ,TIME,RATIO>.....>TIME
        UPPER CHANNEL NO. <1-8>.....>5
        LOWER DISPLAY <FREQ,TIME,RATIO>.....>FREQ
        LOWER CHANNEL NO. <1-8>.....>5
        MAX FREQUENCY <2500,1250,625,250>.....>2500          5-CHAN5
        # LINES/RESOLUTION <500,250,125>.....>500/5.00Hz    RNG=AUTO
          frame time = 200 msec
        DEGREES OF FREEDOM <Enter value 25 to 400>100
          Enter 0 for no averaging                           5-CHAN5
V²                                                           RNG=AUTO
/
Hz
        CH5 FULL SCALE RANGE <Auto,10-.01 V>.....>Auto

                                                             DOF= 100
        use 'Enter' key to toggle through selections.        LNS= 500
        press 'End' when selections are complete.            RES=5.00
                                                              ?-Help

CH5 VRMS:                          STATUS: Auto Ranging

| F1-Display Setup | | F5-Auto Range | | |
|---|---|---|---|---|
| F2-Configure | F4-Print Screen | | | F10-Leave Analyz |
```

Pressing (Shift,?) and then (PgDn) displays the two HELP pages below, which describe the choices available for the DISPLAY SETUP Menu.

Fig.7-10

```
                    DISPLAY SETUP MENU

DISPLAY(s) - Choose "Both" for two displays. A choice of "Upper" or "Lower"
     provides one display and the associated parameters described below.

UPPER DISPLAY - Choose "Freq" for PSD analysis, "Time" for a display of the
     input signal vs. time for a maximum of of one time frame or "Ratio" for
     a display of the upper channel PSD divided by the lower channel PSD
     on the upper half of the screen when "Both" is chosen above. Note that
     a choice of "Ratio" will be ignored if the same channel is selected for
     both upper and lower channel numbers.

UPPER CHANNEL NO. - Select the input signal channel for the selected display
     on the upper half of the screen.

LOWER DISPLAY - Choose "Freq", "Time", or "Ratio" for the corresponding
     display on the lower half of the screen when "Both" is chosen above.

LOWER CHANNEL NO. - Select the input signal channel for the selected display
     on the lower half of the screen.


          PgDn - to continue       Esc - back to menu
```

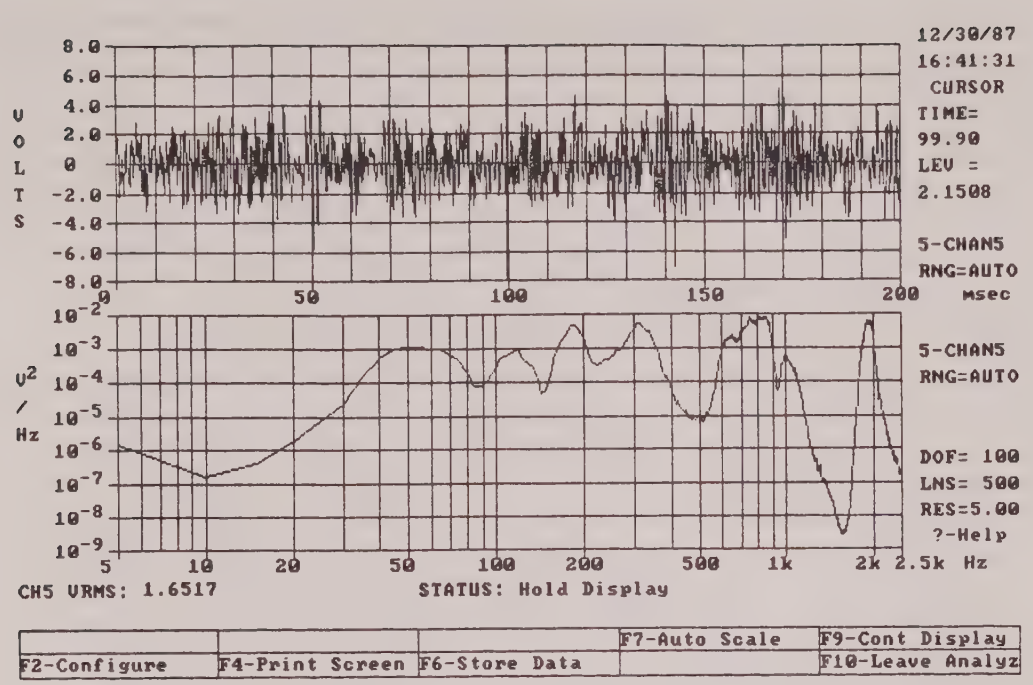
Fig.7-11

```
                    DISPLAY SETUP MENU

MAX FREQUENCY - Select the maximum frequency for PSD analysis.

# LINES/RESOLUTION - Select the number of equally spaced frequency values
     for PSD computation and display. The number of waveform (time) points
     available is 4.096 times the number of lines. The frequency resolution
     and also the minimum PSD analysis frequency is displayed along with the
     duration of the time frame for data collection.

DEGREES OF FREEDOM - Enter the degrees of freedom desired for PSD analysis.
     This determines the statistical confidence interval displayed for the
     exponential average in the processor. The frame discount factor for
     the averager is automatically set. Averaging may be disabled by
     entering 0.

CHx FULL SCALE RANGE - Select the maximum input voltage that may be accepted
     without clipping. Selecting "Auto" causes the analyzer to select the
     correct range based on the rms value of the current signal. If two
     different channels have been selected, a FULL SCALE RANGE query will be
     made for each channel.

PgUp - back up one screen   PgDn - forward one screen   Esc - back to menu
```

Pressing (Esc) causes the menu in Fig.7-9 to reappear. No changes in the display parameters were made. Pressing (End) causes the analyzer to resume operation. The STATUS message "Auto Ranging" disappears, the time function and PSD graphs appear, and are periodically updated.

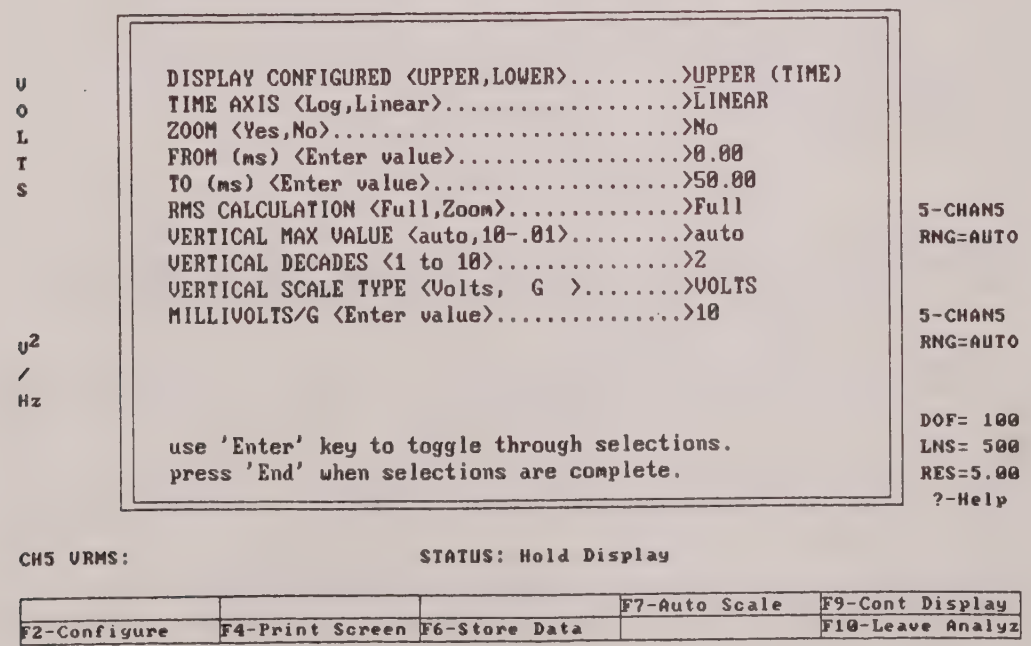
Pressing (F9) keeps the display from updating so that the display shown in Fig.7-12 could be printed by pressing (F4).

Fig.7-12



(F2) was pressed so that the graphs in Fig.7-12 could be examined in finer detail. The CONFIGURE DISPLAY Menu in Fig.7-13 appeared.

Fig.7-13



Pressing (Shift,?) and then (PgDn) twice displays the HELP pages for the CONFIGURE DISPLAY Menu. These are shown on the next page in Figs.7-14, 7-15 and 7-16.

Fig.7-14

CONFIGURE DISPLAY MENU

DISPLAY CONFIGURED - Toggle between the selections made in the DISPLAY SETUP MENU for the upper and lower displays, when a selection of "Both" displays was made.

FREQUENCY or TIME - Select logarithmic or linear display for the horizontal axis.

ZOOM - A "yes" selection causes the horizontal axis to show the range indicated by the two entries immediately following. A "no" selection shows the entire frequency range or the entire time frame selected on the DISPLAY SETUP MENU.

FROM - Enter the lowest value for the horizontal axis when using zoom.

TO - Enter the highest value for the horizontal axis when using zoom.

RMS CALCULATION - Select "Full" to produce rms calculations for the entire frequency range that is being analyzed, or "Zoom" to produce rms calculations that are based only on the portion currently displayed.

PgDn - to continue Esc - back to menu

Fig.7-15

CONFIGURE DISPLAY MENU

VERTICAL MAX VALUE - Select the upper limit of the vertical axis. Selecting AUTO provides a determination of the appropriate maximum and minimum values for the vertical axis, so that all values of the measured PSD will appear on the display.

VERTICAL DECADES - For PSD displays, when AUTO has not been selected previously, this selection determines the number of decades shown on the vertical axis.

VERTICAL VARIABLE - Select V2/Hz or G2/Hz for PSD displays and VOLTS or G for time displays.

MILLIVOLTS/G - Enter the correct conversion factor for conversion from millivolts to G's.

PgUp - back up one screen PgDn - forward one screen Esc - back to menu

Fig.7-16

CONFIGURE DISPLAY MENU

↑↓ - Moves the cursor to the entry above/below the current position.

Enter - Toggles through the available choices, except for the FROM, TO and MILLIVOLTS/G entries, which must be typed.

End - Implements the new selections and returns to the data display(s).

Esc - Abandons all changes and returns to the data display(s).

PgUp - back up one screen Esc - back to menu

Pressing (Esc) causes the Menu in Fig.7-13 to reappear. The UPPER(TIME) display was reconfigured so that:

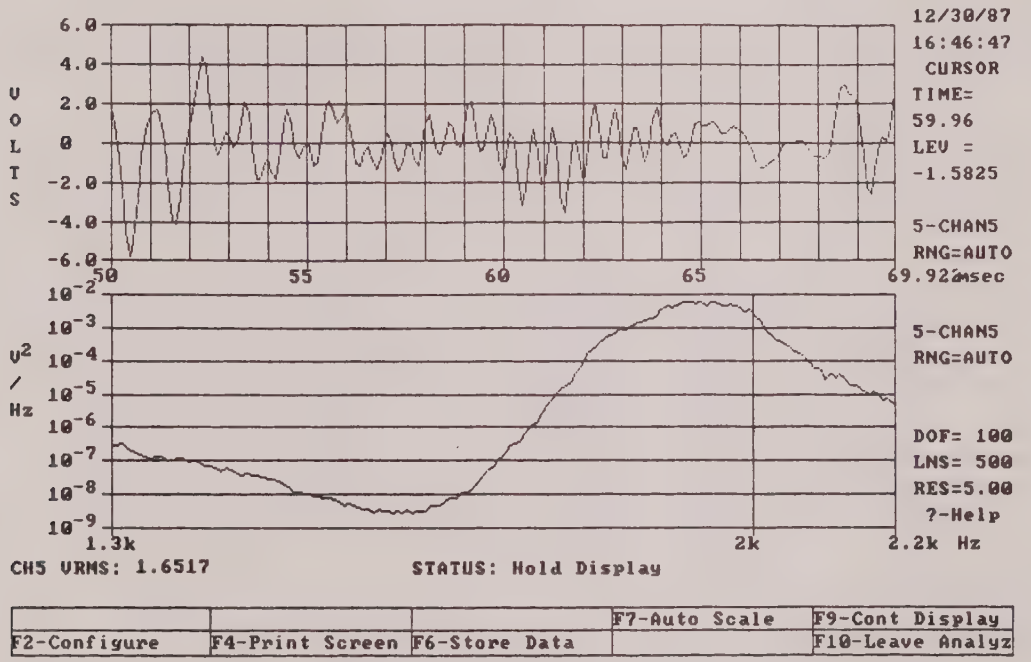
```
ZOOM <Yes,No>.....> Yes
FROM (ms)<Enter value>..> 50.
TO (ms)<Enter value>....> 70.
```

The LOWER(FREQ) display was then reconfigured so that:

```
ZOOM <Yes,No>.....> Yes
FROM (Hz)<Enter value>..> 1300
TO (Hz)<Enter value>....> 2200
```

Pressing (End) caused the "zoom" display in Fig.7-17 to appear.

Fig.7-17



The cursor can be used to measure specific coordinates on the time function in Fig.7-17, and can be toggled to the PSD graph by pressing the "down" arrow key.

After the display in Fig.7-17 was examined, (F9) was pressed to allow the analyzer to continuously update the display.

At this point (F10) could have been pressed to return to the MEASUREMENT/ANALYZE Menu in Fig.7-2. However, we proceeded to demonstrate the data saving and recalling procedures, which are discussed in the following section.

7.5 Data Saving and Recalling

At any time when data is being displayed and (F6-Store Data) is shown in the Function Key display near the bottom of the screen, A data save is initiated by pressing (F6).

After pressing (F6), the request

ENTER DATA SAVE NAME:

appears above the graphs at the top of the screen.

(RANDOM) was entered in response to the request, and the displayed data at the end of the procedure in Section 7.4 was saved on the hard disk.

Pressing (F10) caused a return to the MEASUREMENT/ANALYZE Menu in Fig.7-2.

As an aid in recalling the data stored by the above procedure, (F4) was pressed to display the list of data sves shown in Fig.7-18. The data save (RANDOM) is pointed out on this list.

Fig.7-18

DISPLAY LIST OF ANALYZE DATA SAVES

	NAME	DATE	TIME
1	100HZ	11/18/87	09:11:19
2	200HZLG	11/18/87	11:28:06
3	300HZ	11/18/87	14:46:26
4	30HZ	11/18/87	15:45:22
5	30HZ3	11/19/87	08:29:43
6	45HZ	11/24/87	16:43:34
7	A1250125	10/08/86	16:39:37
8	A250125	10/08/86	16:45:11
9	A625125	10/08/86	16:49:10
10	DEMO2	11/17/87	09:32:43
11	DEMO32	11/17/87	09:40:01
12	DEMO4	11/17/87	09:44:40
13	DUAL	09/02/86	10:41:00
14	GERRY	11/09/87	15:03:34
15	GR	11/25/87	09:48:18
16	HUGHES	08/29/86	17:00:52
17	RANDOM	12/31/87	10:27:58
18	RANDOMTR	11/10/87	17:33:24
19	SAV01	09/09/86	19:45:47
20	SAV02	09/09/86	19:51:56
21	SAV03	09/09/86	19:54:22
22	SAV04	09/09/86	19:54:54

CONTROL KEYS Esc hit any key to continue

(Esc) was pressed to return to the M/A Menu.
(F3) was pressed to initiate a data display.

The request

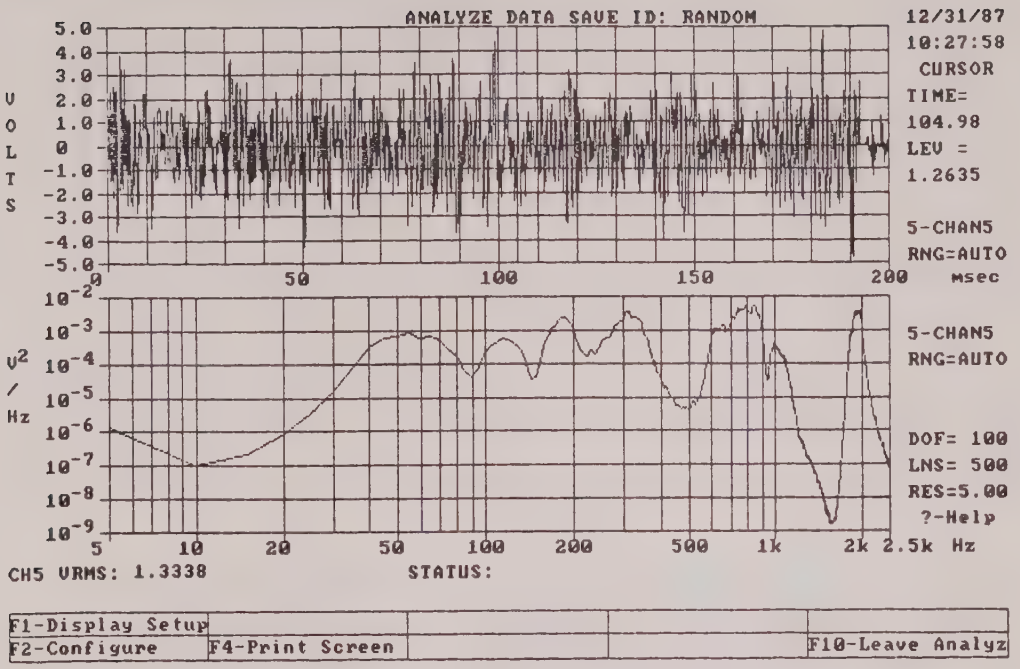
ENTER DATA SAVE NAME:

appears below the Menu.

(RANDOM) was entered in response to the request.

A graphical display appears on the monitor which is identical to the one displayed at the time the (F6-Store Data) command was made. The display is shown on the next page in Fig.7-19.

Fig.7-19



The Display Setup and Configuration can be changed by using the (F1) and (F2) Function Keys. However, only certain entries in the DISPLAY SETUP Menu can be changed. These are noted on the final HELP page shown in Fig.7-20. It is obtained by pressing (F1), (Shift,?), (PgDn) and (PgDn) in succession.

Fig.7-20

```
                    DISPLAY SETUP MENU (page 3)

↑↓ - Moves the cursor to the entry above/below the current position.

Enter  - Toggles through the available choices, except for the DEGREES OF
         FREEDOM, which must be typed.

End    - Saves the new selections and returns to the data display(s). If
         automatic FULL SCALE RANGE selection has been made for an input
         channel, Auto Ranging will be repeated before the data are
         displayed.

Esc    - Abandons all changes and returns to data display(s).

   ********************************************************************
   *  For DISPLAYS of SAVED DATA only the DISPLAY(s), UPPER DISPLAY   *
   *  and LOWER DISPLAY entries may be changed.                       *
   ********************************************************************


         PgUp - back up one screen     Esc - back to menu
```

Data printouts are obtained by pressing (F4) after a satisfactory setup and configuration has been obtained. This concludes the demonstration of the data saving and recalling procedures.

Press (Esc) and (F10) to return to the M/A Menu.

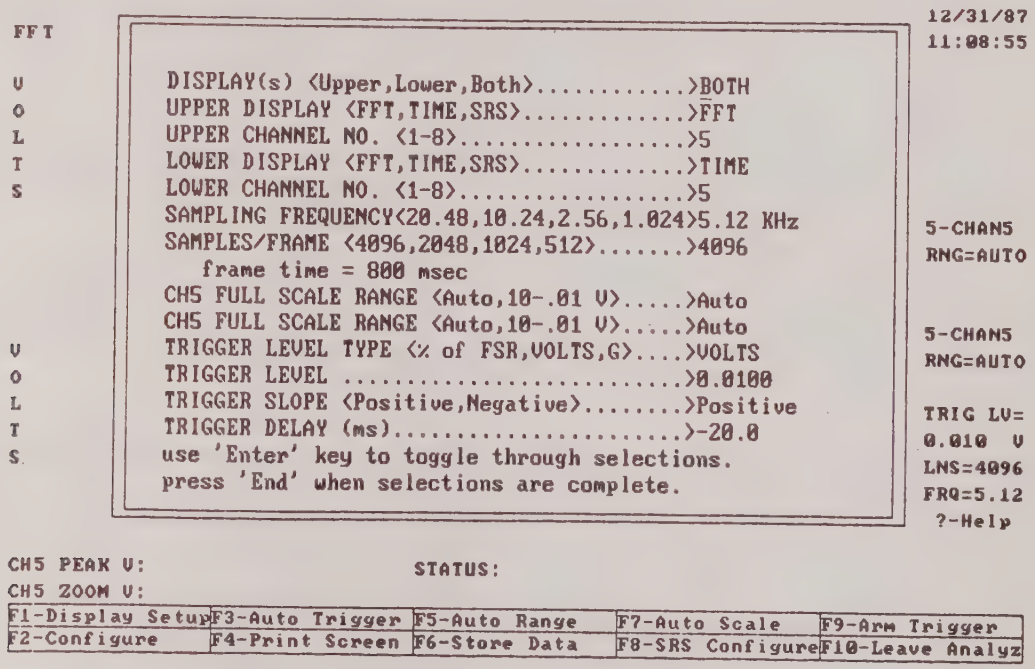
7.6 Triggered Signal Capture (CAPTURE SIGNAL(s))

To demonstrate the procedures and capabilities of the 400AT for triggered signal capture, we connected the output signal of a commercial sinusoidal signal generator (Krohnhite Model 4100) to the 10mV/g input for channel 5 of the UD320. The purpose of the investigation is to examine the waveform of the signal generator immediately after the AC power switch is turned on.

The amplitude control on the oscillator was adjusted for approximately 1 Vrms and the power switch was turned off.

With the MEASUREMENT/ANALYZE Menu displayed on the monitor (See Fig.7-2), (F1) was pressed. After a short interval, the DISPLAY SETUP Menu shown in Fig.7-21 was shown. The entries displayed were either confirmed or made.

Fig.7-21



Pressing (Shift,?), then (PgDn) and another (PgDn) yields the three HELP pages shown in Figs.7-22, 7-23 and 7-24. Note particularly the small value for the TRIGGER LEVEL and the negative value for the TRIGGER DELAY. The negative TRIGGER DELAY starts the recorded frame 20 ms before the start of the oscillator voltage transient.

Fig.7-22

DISPLAY SETUP MENU

DISPLAY(s) - Choose "Both" for two displays. A choice of "Upper" or "Lower" provides one display and the associated parameters described below.

UPPER DISPLAY - Choose "Time" for a display of the input signal vs. time, "SRS" for a display of the Shock Response Spectrum, or "FFT" for a display of the Fourier Transform of the most recently captured signal on the upper half of the screen when "Both" is chosen above.

UPPER CHANNEL NO. - Select the input signal channel for the selected display on the upper half of the screen.

LOWER DISPLAY - Choose "Time", "FFT" or "SRS" for the corresponding display on the lower half of the screen when "Both" is chosen above.

LOWER CHANNEL NO. - Select the input signal channel for the selected display on the lower half of the screen.

SAMPLING FREQUENCY - Select the rate at which the signal is sampled. Note that only one channel is available when the sampling frequency is 20.48 kHz.

PgDn - to continue Esc - back to menu

Fig.7-23

DISPLAY SETUP MENU

SAMPLES/FRAME - Select the number of equally spaced frequency values in each frame that is captured. The number of points that are calculated for the FFT is 10/32 times the number of samples. The duration of the time frame is also displayed.

CHx FULL SCALE RANGE - Select the maximum input voltage that may be accepted without clipping. Selecting "Auto" causes the analyzer to select the correct range based on the peak values of the next several frames that are captured. If two different channels have been selected, a FULL SCALE RANGE query will be made for each channel.

TRIGGER LEVEL TYPE - Select the units to be used in interpreting the TRIGGER LEVEL entry. "% of FSR" means percent of the upper channel FULL SCALE RANGE entry.

TRIGGER LEVEL - Enter the level that the signal must cross on the upper channel to trigger the capture of a new frame of data.

PgUp - back up one screen PgDn - forward one screen Esc - back to menu

Fig.7-24

DISPLAY SETUP MENU

TRIGGER SLOPE - Select "Positive" to trigger when the signal increases to a level that is above the TRIGGER LEVEL, or "Negative" to trigger when the signal decreases to a level that is below the TRIGGER LEVEL.

TRIGGER DELAY - Enter the amount of time in milliseconds between the trigger and the first sample in the captured frame. This value may range from minus one times the frame size (trigger at the end of the frame) to 32767 samples after the trigger.

↑ ↓ - Moves the cursor to the entry above/below the current position.

Enter - Toggles through the available choices, except for the TRIGGER LEVEL and TRIGGER DELAY, which must be typed.

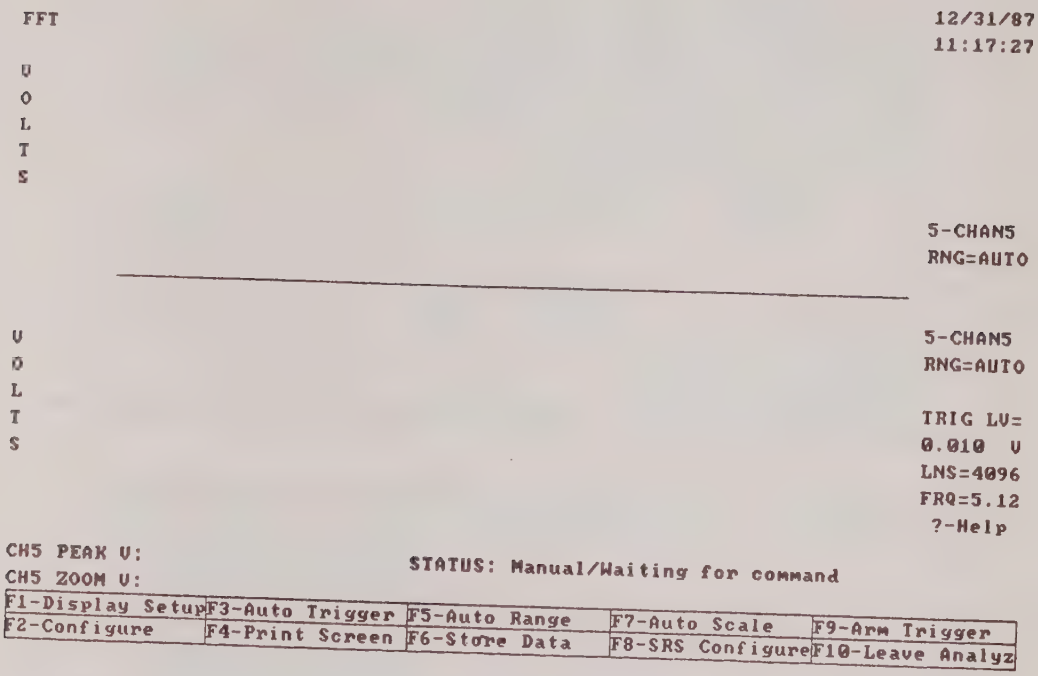
End - Saves the new selections and returns to the data display(s). If automatic FULL SCALE RANGE selection has been made for an input channel, Auto Ranging will be repeated before the data are displayed.

Esc - Abandons all changes and returns to data display(s).

PgUp - back up one screen Esc - back to menu

Pressing (Esc) and (End) caused the blank display in Fig.7-25 to appear.

Fig.7-25



Pressing (Shift,?) and (PgDn) twice produces the three HELP pages shown in Figs.7-26, 7-27 and 7-28. These explain the operation of the Function Keys. Note particularly the explanation of the action for (F3) and (F9).

Fig.7-26

CAPTURE SIGNAL(s) MENU

F1 - DISPLAY SETUP - Produces a menu which allows selection of as many as two input channels to be analyzed simultaneously, and also trigger conditions (level,slope, and delay between trigger and buffer start), input channel analysis parameters such as sampling frequency, number of samples per frame, and full-scale input voltage. Choice of frequency domain (FFT or SRS) and time domain (signal vs. time) displays is also provided.

F2 - CONFIGURE - Produces a menu which allows selection of the scales for the vertical and horizontal axes of the display(s). A zoom feature for the horizontal axes is provided along with automatic scaling and signal normalization for plotting g's.

F3 - AUTO TRIGGER - Press to have the trigger conditions checked continuously, and signals displayed each time the conditions are met. See F9 - MAN TRIGGER to leave this mode.

F4 - PRINT SCREEN - Printer provides a copy of the screen with 90 degree rotation for optimum aspect ratio.

PgDn - to continue Esc - back to menu

Fig.7-27

CAPTURE SIGNAL(s) MENU

F5 - AUTO RANGE - Press to re-estimate and reset the gain of the analyzer when an input level or spectral content is changed. This optimizes the signal level at the input to the digital processor for maximum signal to noise ratio.
The vertical axes for the displays are automatically adjusted before the new displays are presented.

F6 - STORE DATA - Saves a time frame for each display, and an SRS for each display for which an SRS has been calculated. Entry of a data save ID is required.

F7 - AUTO SCALE - Press to re-estimate and adjust the scale on the vertical axes to best display the time and/or frequency data. This command and also the F5 command override and change fixed full scale range and scale entries on the DISPLAY SETUP and CONFIGURE DISPLAY MENUS.

F8 - SRS CONFIG - Produces a menu that allows the user to select the manner in which Shock Response Spectra will be calculated. If any parameters in this menu are changed, the SRS will be recalculated.

PgUp - back up one screen PgDn - forward one screen Esc - back to menu

Fig.7-28

CAPTURE SIGNAL(s) MENU

F9 - MAN TRIGGER - Press to leave the AUTO TRIGGER mode and enter the MANUAL TRIGGER mode. The meaning of the F9 key will the change to ARM TRIGGER.
or
F9 - ARM TRIGGER - Press to set the trigger for a single signal. After the trigger conditions have been met, the result is displayed and the message HOLD DISPLAY appears. No other signal will be captured until F3 or F9 is hit again.

F10 - LEAVE ANALYZE - Returns to the previous menu.

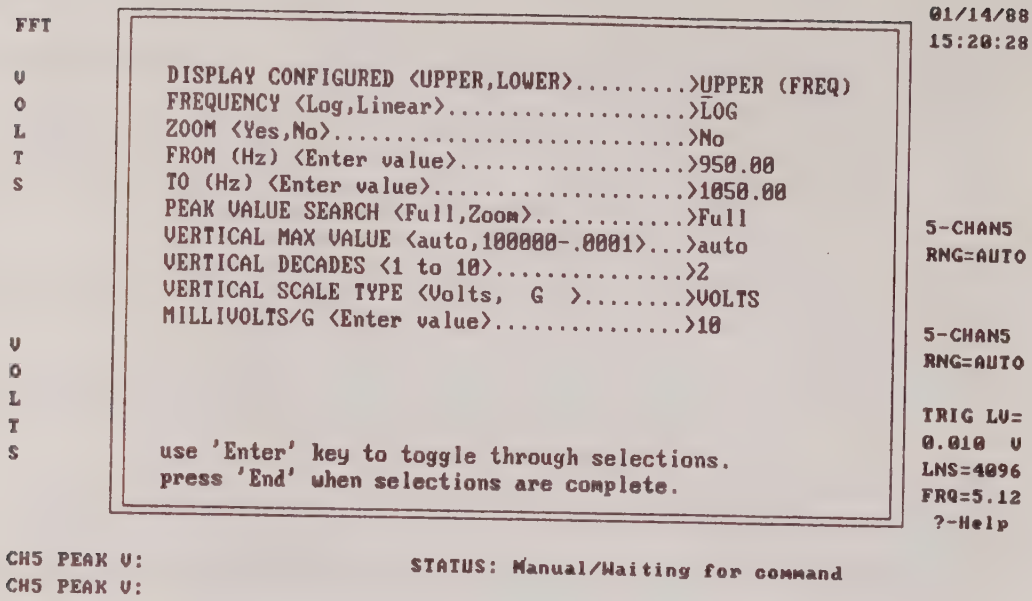
↑↓ - The cursor appears in one display at a time. The up and down arrow keys move the cursor from one display to the other.

(- -) - Momentary action moves the cursor one data point to the right or left. Holding the key down causes repetitive action. Depressing the shift key simultaneously causes the cursor to move several data points at a time.

PgUp - back up one screen Esc - back to menu

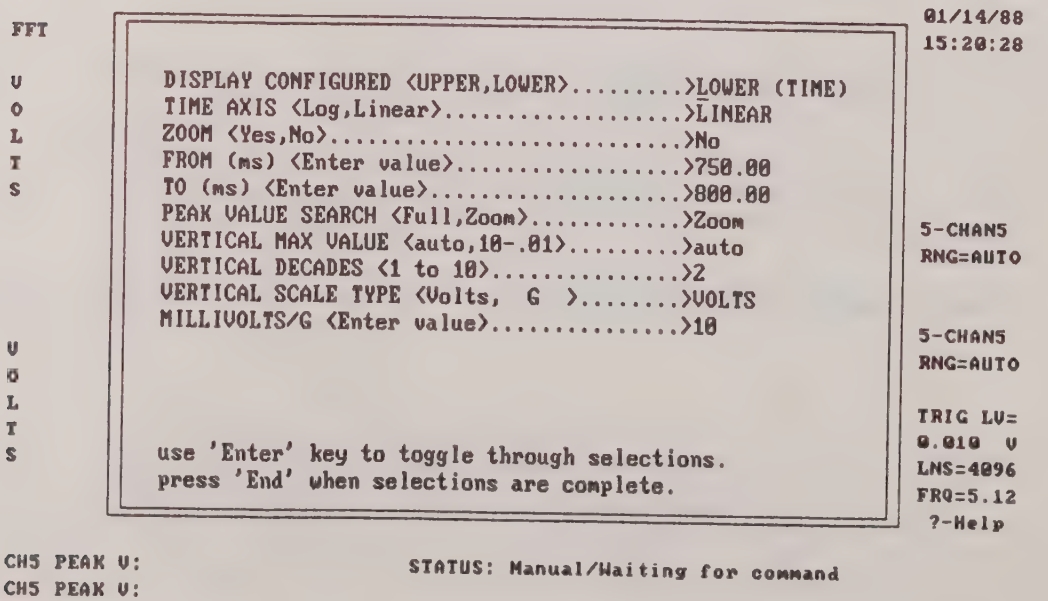
Pressing (Esc) returned the blank display shown in Fig.7-25. Pressing (F2) provided the CONFIGURE DISPLAY Menu shown in Fig. 7-29. We made sure that the entry for ZOOM was toggled to (No), so that the full frequency range from 1.25 t0 1600 Hz would be displayed.

Fig.7-29



The UPPER(FREQ) entry was toggled to LOWER(TIME) to get the CONFIGURE DISPLAY Menu in Fig.7-30. We made sure that the ZOOM entry was (No) to obtain a display for the entire frame from 0 to 800 ms.

Fig.7-30



Pressing (Shift,?) then (PgDn) obtained the two HELP pages for the CONFIGURE DISPLAY Menu shown in Figs. 7-31 and 7-32.

Fig.7-31

CONFIGURE DISPLAY MENU

DISPLAY CONFIGURED - Toggle between the selections made in the DISPLAY SETUP MENU for the upper and lower displays, when a selection of "Both" displays was made.

FREQUENCY or TIME - Select logarithmic or linear display for the horizontal axis.

ZOOM - A "yes" selection causes the horizontal axis to show the range indicated by the two entries immediately following. A "no" selection shows the entire frequency range or the entire time frame selected on the DISPLAY SETUP MENU.

FROM - Enter the lowest value for the horizontal axis when using zoom.

TO - Enter the highest value for the horizontal axis when using zoom.

PEAK VALUE SEARCH - Select "Full" to cause the peak value shown in the lower left corner to be based on the entire time frame, or "Zoom" to produce peak values that are based only on the portion currently displayed.

PgDn - to continue Esc - back to menu

Fig.7-32

CONFIGURE DISPLAY MENU

VERTICAL MAX VALUE - Select the upper limit of the vertical axis. Selecting AUTO provides a determination of the appropriate maximum and minimum values for the vertical axis, so that all values will appear on the display.

VERTICAL DECADES - For FFT or SRS displays, when AUTO has not been selected previously, this selection determines the number of decades shown on the vertical axis.

VERTICAL VARIABLE - Select VOLTS or G.

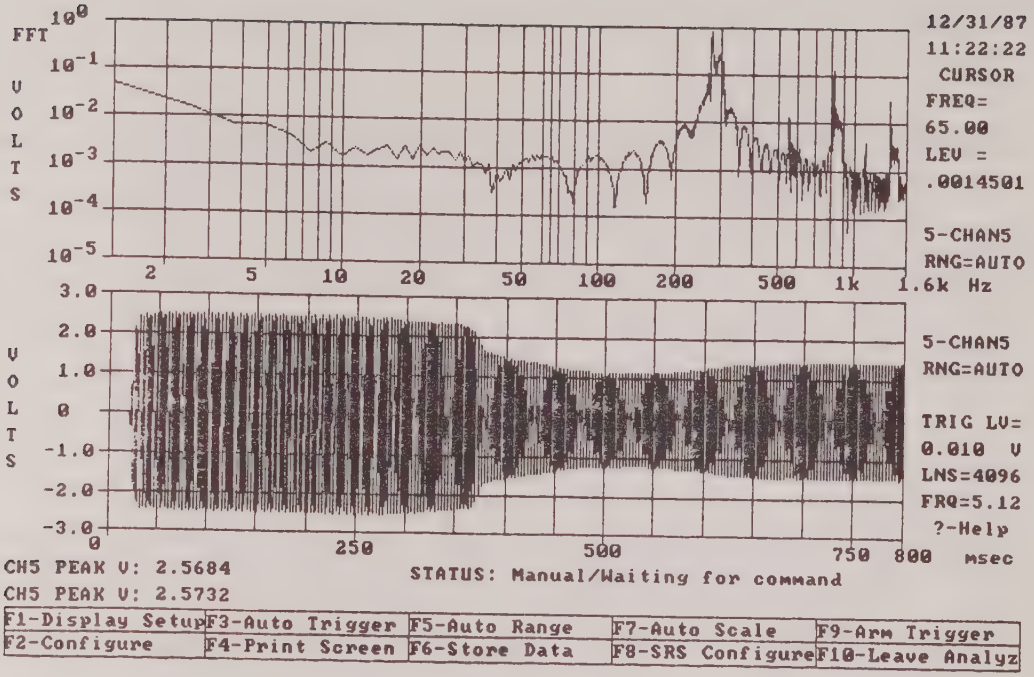
MILLIVOLTS/G - Enter the correct conversion factor for conversion from millivolts to G's.

PgUp - back up one screen PgDn - forward one screen Esc - back to menu

Pressing (Esc), then (End) caused the blank display to reappear. We pressed (F9) to arm the trigger and then turned ON the AC power switch for the signal generator.

After a few seconds, the display shown in Fig.7-33 appeared.

Fig.7-33



From the lower graph in Fig.7-33, the oscillation amplitude can easily be seen after its sudden growth from zero near 20 ms. The waveform purity is impossible to discern because the fundamental frequency is about 300 Hz (the period is only 3.3 ms). Due to the nonsinusoidal character of the waveform over at least part of the 800 ms time frame, the upper graph for the FFT shows many peaks and valleys, with major peaks at 300, 900 and 1500 Hz.

In order to get more information about the waveshape, it was necessary to change the display setup and configuration.

Pressing (F1) displayed the DISPLAY SETUP Menu in Fig.7-21.
The entry for UPPER DISPLAY was toggled to TIME.
Pressing (End) and then (F2) obtained the DISPLAY CONFIGURATION Menu in Fig.7-34. Note that UPPER(FREQ) was changed automatically to UPPER(TIME). The entries for ZOOM, FROM and TO were changed to agree with those in Fig.7-34.

Then UPPER(TIME) was toggled to LOWER(TIME) and the following entries were changed as below:

ZOOM〈Yes,No〉.....〉Yes
FROM (ms)〈Enter value〉.....〉750
TO (ms)〈Enter value〉.....〉800

Pressing (End) caused the two time function graphs shown in Fig.7-35.

Fig.7-34

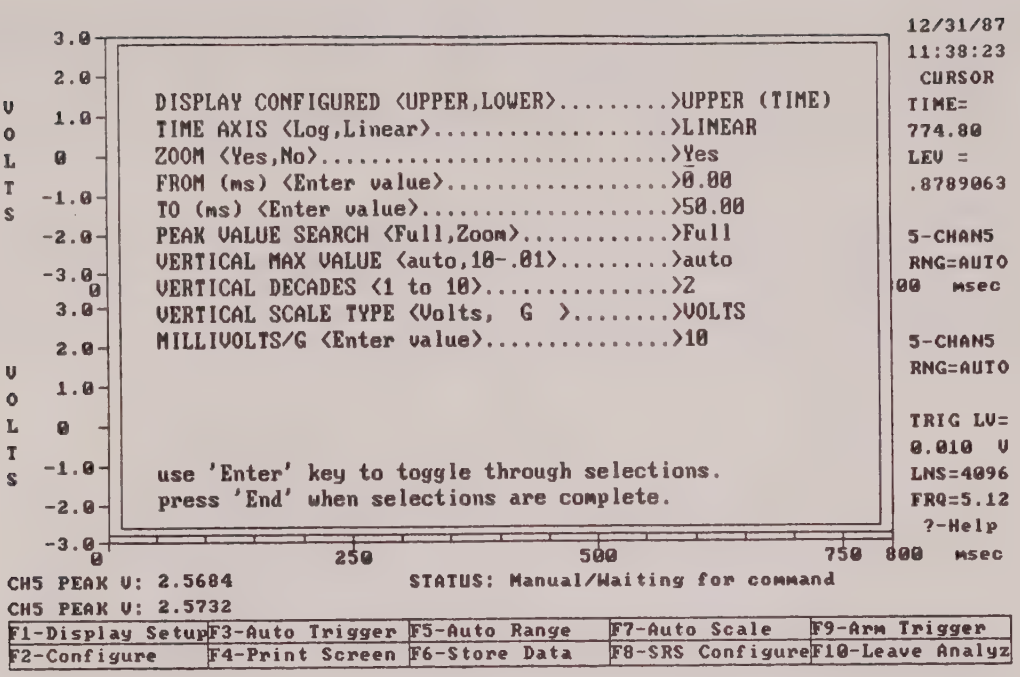
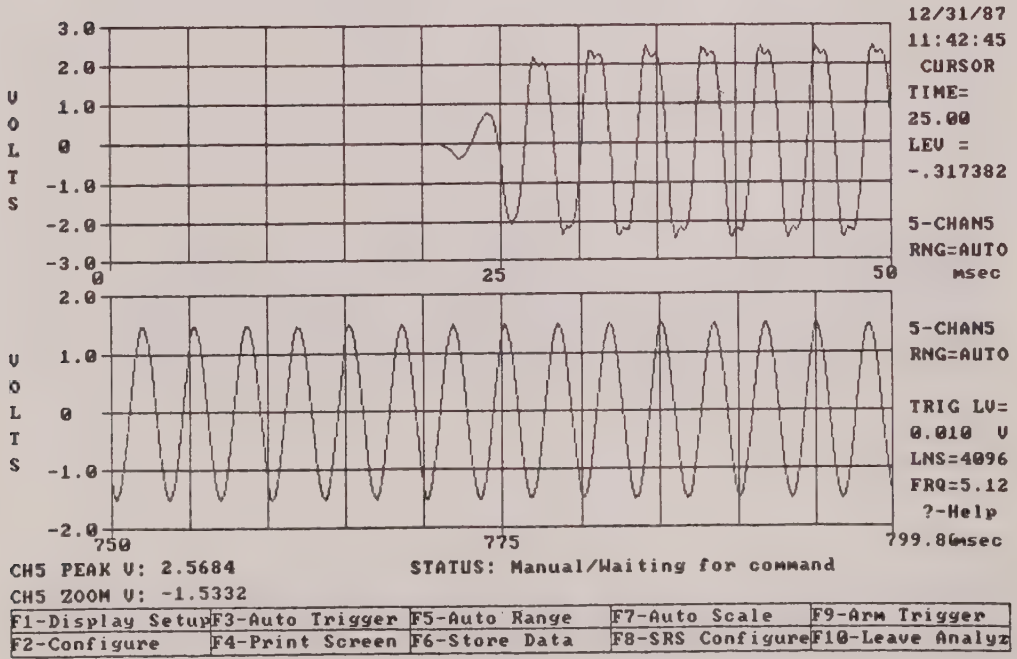


Fig.7-35



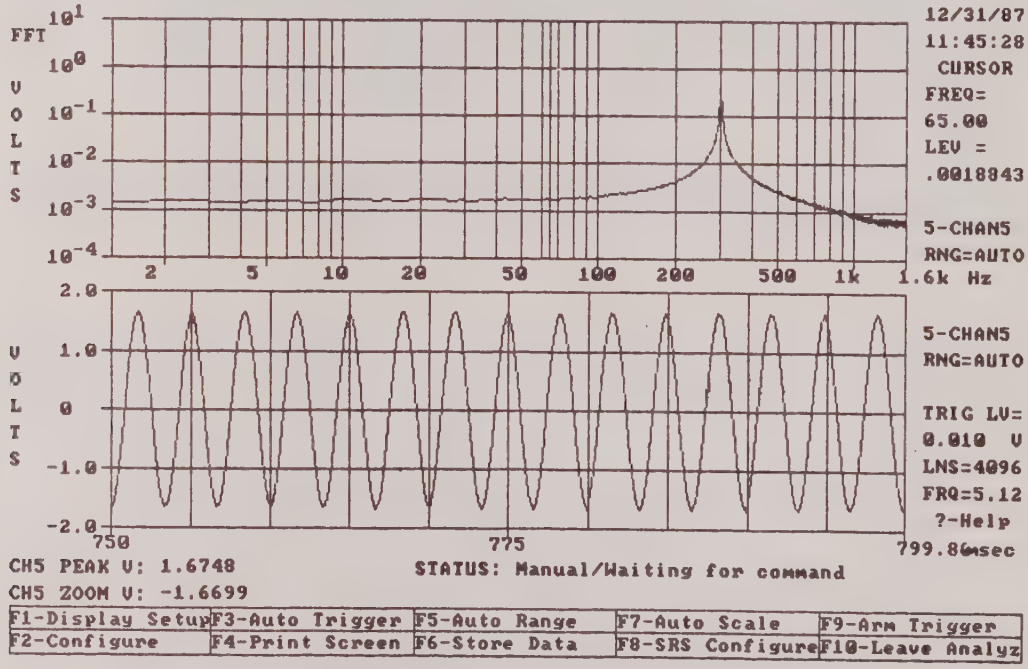
The displays in Fig.7-35 clearly show that the amplitude increases suddenly after the power switch is turned ON, and the waveform is clipped at the peaks for the first 250 ms (See also Fig.7-33). Near the end of the frame the waveform appears sinusoidal and appears to have stabilized at about 1.53 V peak.

In order to obtain a check on steady-state performance of the oscillator, (F1) was pressed, UPPER DISPLAY was toggled from TIME to FFT and (End) was pressed.

With the oscillator power switch remaining ON, (F9) was pressed to rearm the trigger.

In a few seconds the trigger was tripped and the display shown in Fig.7-36 had appeared. The waveform looks sinusoidal, and the FFT shows no discernable harmonic distortion components. More rapid falloff from the peak value of the FFT would have been obtained had the oscillator frequency been exactly equal to 300Hz (one of the FFT line frequencies).

Fig.7-36



The demonstration of triggered signal capture did not involve the measurement of the Shock Response Spectrum (SRS). A brief discussion of this feature follows in the next section.

Data saving and recalling requires the same operations as those required for ANALYZE SIGNAL(s) - asynchronous signal capture. See Section 7.5.

7.7 Shock Response Spectrum (SRS) Measurement

Measurement of the SRS for triggered signal capture is initiated on the DISPLAY SETUP Menu shown in Fig.7-21. Either or both entries for UPPER DISPLAY and LOWER DISPLAY may be toggled to SRS for the channel(s) selected.

The parameters for the SRS measurement are shown on the CONFIGURE SRS Menu. This menu is displayed by pressing (F8) from the blank display in Fig.7-25, or whenever data is displayed.

Pressing (F8) from the blank display in Fig.7-25 gives the CONFIGURE SRS Menu in Fig.7-37 for the UPPER DISPLAY:

Fig.7-37

```
SRS DISPLAY CONFIGURED (Upper,Lower).....)Upper Display
FREQUENCY RANGE (Wide,Normal,User def'd)....)Normal
LOW FREQUENCY (Hz) (Enter value).....)3.75
HIGH FREQUENCY (Hz) (Enter value).....)1280.00
OCTAVE SPACING (1-24).....)1/6
SRS DAMPING (percent) (Enter value 0 to 10).)5.0
SHOCK FILTER (Absolute Acc,Relative Disp)...)Abs Acc
TYPE(Maximax,Pos-pri,Neg-pri,Pos-res,Neg-res)Maximax

use 'Enter' key to toggle through selections.
press 'End' when selections are complete.
```

Toggling the entry for SRS DISPLAY CONFIGURED to LOWER DISPLAY shows the parameters for a SRS measurement shown in the lower display:

Fig.7-38

```
SRS DISPLAY CONFIGURED (Upper,Lower).....)Lower Display
FREQUENCY RANGE (Wide,Normal,User def'd)....)Wide
LOW FREQUENCY (Hz) (Enter value).....)1.25
HIGH FREQUENCY (Hz) (Enter value).....)2560.00
OCTAVE SPACING (1-24).....)1/6
SRS DAMPING (percent) (Enter value 0 to 10).)5.0
SHOCK FILTER (Absolute Acc,Relative Disp)...)Abs Acc
TYPE(Maximax,Pos-pri,Neg-pri,Pos-res,Neg-res)Maximax

use 'Enter' key to toggle through selections.
press 'End' when selections are complete.
```

It is advisable to view these menus and check/edit the entries before the desired signal is captured because the default entries for these menus remain unchanged from the most recent editing process.

For a discussion of the parameters involved, consult Section 1.6 in the 400AT/T Instruction Manual.

The LOW FREQUENCY and HIGH FREQUENCY entries automatically reflect the proper values when NORMAL or WIDE is chosen for the FREQUENCY RANGE. The WIDE frequency range extends from the minimum line frequency (sampling frequency/block size) to 50% of the sampling frequency. The NORMAL frequency range extends from 3 times the minimum line frequency to 25% of the sampling frequency. The USER DEFINED frequency range requires the operator to make appropriate entries for LOW FREQUENCY and HIGH FREQUENCY.

The START TIME and END TIME entries are meaningful only when a primary or residual measurement is indicated by the TYPE entry.

Press (End) when parameter entries are satisfactory and return to the data collecting process by pressing (F3) or (F9).

SRS measurements may also be made on saved data from the CAPTURE SIGNAL(s) Mode, even though such measurements were not made at the time the original data was saved.

The procedure to follow is identical to that above, once the saved data is retrieved by pressing (F3) from the MEASUREMENT/ANALYZE Menu and entering the NAME for the saved data. The default parameters for the SRS measurement were those in effect at the time of the data save, even though they may not have been exercised. It is again advisable to inspect and edit them using the procedure above before any measurements are made.

MP MASTER
MA31521

UNHOLTZ-DICKIE CORPORATION
BARNES INDUSTRIAL PARK NORTH ■ 6 BROOKSIDE DRIVE, WALLINGFORD, CONNECTICUT 06492 ■ (203)265-3929